PB84-223049

Environmental Assessment of a Crude-Oil Heater Using Staged Air Lances for NOx Reduction
Volume 2. Data Supplement

Acurex Corp., Mountain View, CA

Prepared for

Industrial Environmental Research Lab.
Research Triangle Park, NC

Jul 84

U.S. Department of Commerce
National Technical Information Service
NTIS

PB84-223049

EPA-600/7-84-074b
July 1984

ENVIRONMENTAL ASSESSMENT OF A CRUDE-OIL HEATER USING STAGED AIR LANCES FOR NO_x REDUCTION

Volume II
Data Supplement

By

R. DeRosier and B. DaRos
Acurex Corporation
Energy & Environmental Division
555 Clyde Avenue
P.O. Box 7555
Mountain View, California 94039

EPA Contract 68-02-3188

EPA Project Officer: Robert E. Hall
Industrial Environmental Research Laboratory
Research Triangle Park, North Carolina 27711

INDUSTRIAL ENVIRONMENTAL RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-600/7-84-074b	2.	3. RECIPIENT'S ACCESSION NO. PB84 223049
4. TITLE AND SUBTITLE Environmental Assessment of a Crude-Oil Heater Using Staged Air Lances for NO_x Reduction; Volume II. Data Supplement		5. REPORT DATE July 1984
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) R. DeRosier and B. DaRos		8. PERFORMING ORGANIZATION REPORT NO. TR-82-94/EE
9. PERFORMING ORGANIZATION NAME AND ADDRESS Acurex Corporation P.O. Box 7555 Mountain View, California 94039		10. PROGRAM ELEMENT NO.
		11. CONTRACT/GRANT NO. 68-02-3188
12. SPONSORING AGENCY NAME AND ADDRESS EPA, Office of Research and Development Industrial Environmental Research Laboratory Research Triangle Park, NC 27711		13. TYPE OF REPORT AND PERIOD COVERED Final; 6/81 - 11/83
		14. SPONSORING AGENCY CODE EPA/600/13

15. SUPPLEMENTARY NOTES IERL-RTP project officer is Robert E. Hall, Mail Drop 65; 919/541-2477. Volume I consists of Technical Results.

16. ABSTRACT

This volume of the report is a compendium of detailed emission and test data from field tests of a crude-oil process heater and laboratory analyses of collected samples. The process heater, burning a combination of oil and refinery gas, was tested in two operating modes: baseline (normal operation) and with staged combustion air for NOx reduction. The test data include preliminary equipment calibration, detailed heater operation, and complete flue gas emission measurement results. Exhaust gas emission measurements included continuous monitoring for criteria gas pollutants; onsite gas chromatography (GC) for volatile hydrocarbons (C sub 1 to C sub 6); and source assessment sampling system (SASS) for total organics in two boiling point ranges (100-300 C and >300 C). Organic compound category information was obtained using infrared spectrometry (IR) with specific quantitation of the semivolatile organic priority pollutants using gas chromatography with mass spectrometry (GC/MC). Fractions were determined using liquid chromatography separation of organic extracts with total organic and IR and low resolution mass spectrometry (LRMS). Trace elements were determined by spark source mass spectrometry (SSMS) and atomic absorption spectrometry (AAS). Biological assays of organic sample extracts were also performed.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Pollution	Pollution Control	13B
Nitrogen Oxides	Stationary Sources	07B
Crude Oil	Refinery Gas	11H, 08G
Gases	Environmental Assessment	07D
Assessments		14B
Flue Gases	Staged Combustion	21B
Lances Dis.	Air Lances	13I

18. DISTRIBUTION STATEMENT Release to Public	19. SECURITY CLASS (This Report) Unclassified	21. NO. OF PAGES 263
	20. SECURITY CLASS (This page) Unclassified	22. PRICE

EPA Form 2220-1 (9-73)

NOTICE

THIS DOCUMENT HAS BEEN REPRODUCED FROM THE BEST COPY FURNISHED US BY THE SPONSORING AGENCY. ALTHOUGH IT IS RECOGNIZED THAT CERTAIN PORTIONS ARE ILLEGIBLE, IT IS BEING RELEASED IN THE INTEREST OF MAKING AVAILABLE AS MUCH INFORMATION AS POSSIBLE.

NOTICE

This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

ABSTRACT

This volume of the report presents emission results obtained from field testing of a crude-oil process heater burning a combination of oil and refinery gas. The heater had been modified by the addition of a system for injection of secondary air to reduce NO_x emissions. One test was conducted with the staged air system (low-NO_x), and one was conducted without it (baseline). Tests included continuous monitoring of flue gas emissions and source assessment sampling system (SASS) sampling of the flue gas with subsequent laboratory analysis of samples utilizing gas chromatography (GC), and low resolution mass spectrometry (LRMS) for organics; and atomic absorption spectrometry (AAS) and spark source mass spectrometry (SSMS) for trace metals. Flue gas concentrations of NO_x were reduced 30 percent (from 83 to 56 ng/J) with the staged air system. Total organic emissions dropped from 17.1 to 3.4 mg/dscm from the baseline to the low-NO_x test. This was primarily due to a reduction in the Cl to C6 boiling point range compounds which constituted most of the organic emissions. GC/MS analysis identified 11 semivolatile priority pollutant compounds in both tests, most of them present in higher concentrations during the baseline test. LRMS analysis suggested the presence of eight compound categories in the organic emissions during the baseline test and four compound categories in the low-NO_x test. Biological tests indicated that the organic sorbent module extracts from both tests were of moderate toxicity and moderate-to-high mutagenicity.

TABLE OF CONTENTS

Section Page

1 INTRODUCTION 1-1

2 PRELIMINARY EQUIPMENT CALIBRATION 2-1

3 HEATER OPERATING DATA 3-1

4 SAMPLING DATA SHEETS 4-1

4.1 KVB Continuous Emissions Monitoring Report 4-2
4.2 Operating Data for EPA Method 5 4-21
4.3 Operating Data for Controlled Condensation Train . . 4-34
4.4 Operating Data for SASS 4-41

5 ANALYTICAL RESULTS 5-1

5.1 Ultimate Analysis of Fuel Oil 5-2
5.2 Composition of Refinery Gas 5-4
5.3 SASS Particulate Emissions 5-7
5.4 EPA Method 5 Particulate Emissions 5-13
5.5 Sulfur Oxides Emissions by Turbidimetric Analysis . 5-23
5.6 Trace Element Analysis 5-28
5.7 Total Chromatographable Organics (TCO), Gravimetric Organics (Grav), Infrared (IR) Spectra, Gas Chromatography/Mass Spectrometry (GC/MS) and Low Resolution Mass Spectrometry (LRMS) of Total Sample Extracts 5-42
5.8 C_1-C_6 Chromatograms 5-60
5.9 Radiometric Analysis Results 5-129
5.10 Bioassay Reports 5-131
Mutagenicity Evaluation of XAD Resin Extracts in the EPA Level 1 Ames Salmonella/Microsome Plate Test 5-132
Cytotoxic Evaluation of XAD Resin Extracts in the EPA Level 1 Rodent Cell (CHO) Clonal Toxicity Assay 5-168

SECTION 1

INTRODUCTION

The purpose of this data supplement is to document data in greater detail than was possible in Volume I (Technical Results) of this report. It is intended to provide sufficient detail for researchers to perform their own analysis of the data obtained. Readers are referred to the technical volume for objectives, description of source emission results, interpretation, and conclusions.

The remaining sections of this data supplement contain the following information:

Section 2 -- Preliminary Equipment Calibration Data

Section 3 -- Heater Operating Data: crude-oil temperatures and pressures, process rate, burner pressures, fuel flowrates

Section 4 -- Sampling Data Sheets: KVB continuous emissions monitoring report, operating data tables for EPA Method 5 (for particulate mass emissions), controlled condensation (for SO_2 and SO_3 sampling), and SASS (for trace element and organic sampling)

Section 5 -- Analytical Laboratory Results: ultimate analysis of the fuel oil, composition of reabsorber gas, SASS particulate emissions, sulfur oxides emissions by turbidometric analysis, trace element emissions by spark source mass spectrometry (SSMS) analysis and atomic absorption spectroscopy (AAS) analysis; total chromatographable organic (TCO) and gravimetry (GRAV) results; infrared (IR) spectra; determination of organic compounds by gas chromotography/mass spectrometry (GC/MS); low resolution mass spectrometry (LRMS) of total sample extracts; C_1-C_6 chromatograms, radiometric analysis results, and biological assay reports on the SASS train samples.

SECTION 2

PRELIMINARY EQUIPMENT CALIBRATION

Reproduced from best available copy.

Date 1-8-81
Time 9:30AM
Barometric Pressure 30.18
Ambient Temperature 64°

Orifice Meter
Orifice Magnehelic 80615 Bw28
Primary Calibration Meter 433583
Control Module 084

Operators UNRUH
Wet Bulb Temperature

METER CALIBRATION DATA

1-22-81

small orifice

Orifice Manometer ΔH_ref (in.wg.)	Orifice Magnehelic ΔH_o (in.wg.)	Primary Meter ΔH_p (in.wg.)	Dry Test Meter P_dg (in. wg.)	Gas Volume Primary Meter V_p (ft.³)	Gas Volume Dry Test Meter V_d (ft.³)	Temperature Primary Meter Inlet, T_pi (°F)	Primary Meter Outlet, T_po (°F)	Primary Meter Avg., T_pa (°F)	Dry Test Meter Inlet, T_di (°F)	Dry Test Meter Outlet, T_do (°F)	Dry Test Meter Avg., T_da (°F)	Time t (min.)	γ	K_o
	0.9			443.628 461.882 18.254	359.599 377.565 17.966	74 64	74 68	70	65 63	64 65	64 1/4	52	γ = .9960	K_o = .7167
	0.6 0.8			461.882 482.967 21.085	377.515 398.397 20.882	64 67	68 67	66.5	63 65	65 66	64 3/4	[illegible]	γ = .9956	K_o = .7075
	0.8 1.2			482.967 502.569 19.602	398.397 417.835 19.438	67 69	67 68	67 3/4	65 65	66 66	65.5	33	γ = .9988	K_o = .6943
	1.2 1.6			502.569 523.437 20.868	417.835 438.517 20.682	69 71	65 68	69	65 66	66 67	66	31	γ = 1.0006	K_o = .6860
	1.6													

large orifice

Orifice Manometer ΔH_ref (in.wg.)	Orifice Magnehelic ΔH_o (in.wg.)	Primary Meter ΔH_p (in.wg.)	Dry Test Meter P_dg (in. wg.)	Gas Volume Primary Meter V_p (ft.³)	Gas Volume Dry Test Meter V_d (ft.³)	Temperature Primary Meter Inlet, T_pi (°F)	Primary Meter Outlet, T_po (°F)	Primary Meter Avg., T_pa (°F)	Dry Test Meter Inlet, T_di (°F)	Dry Test Meter Outlet, T_do (°F)	Dry Test Meter Avg., T_da (°F)	Time t (min.)	γ	K_o
	2.2 2.4			535.000 591.082 56.082	450.010 505.318 55.308	82 94	69 76	80 1/4	66 67	67 68	67	30	γ = 1.0120	K_o = 3.8065
	2.6 2.8			591.082 663.000 71.918	505.318 575.846 70.528	94 102	76 83	88 3/4	68 70	68 70	69	28	γ = 1.0193	K_o = 3.6912
	3.0 4.2			663.000 758.457 95.957	575.846 669.561 93.715	102 107	83 88	95	70 73	70 72	71 1/4	31	γ = .9772	K_o = 3.6244
	3.4 1.6			758.457 819.396 60.439	669.561 728.618 59.057	107 110	88 90	98 3/4	73 74	72 73	73	17	γ = 1.0283	K_o = 3.5992
	3.8													
	4.0													
	4.2													
	4.4													
	4.6													
	4.8													
	5.0											Average		

averages: small γ = .9978
K_o = .7024

large γ = 1.0092
K_o = 3.6803

SECTION 3

HEATER OPERATING DATA

Process rate

Crude oil temperature and pressure

- Inlet
- Outlet

Reabsorber gas flow

Burner pressures

- Oil
- Steam
- Gas

Crude API gravity

Tube temperatures

Notes

UNIT OPERATING DATA

Test No. 1 (BASELINE) Date 18 JUNE 1981 Location TOSCO Engr. R. DEROSIER

Unit No. 11H13 Fuel

Capacity 16250 bbl/d, 55×10^6 Btu/h

Unit Type CRUDE HEATER

Burner Type JOHN ZINK DBA-22

Test Description:

Test number	1				
Time	11:56	12:50	1:50	3:50	4:50
Process Rate x 1847.7 bbl/d	6.3	6.3	6.3	6.3	6.3
Crude Tin (°F)	385	384	384	386	384
Crude Tout (°F) East	640	644	645	640	640
Crude Tout (°F) West	635	641	642	636	639
Crude Pin (psig) East	140	140	140	140	140
Crude Pin (psig) West	130	130	130	130	130
Crude Pout (psig)	--	--	--	34	33
Reabsorber gas in x 205.856 (10^3 scf/d)	2.1	2.1	2.2	2.1	2.0
Burner #1	44/80	50/79	50/80	50/80	52/80
Burner #2	44/80	44/80	44/82	44/80	44/80
Burner #3 Oil P/Steam P	--	--	--	--	--
Burner #4 (psig)	44/74	50/75	52/74	50/74	50/76
Burner #5	44/78	46/78	48/76	48/74	44/78
Burner #6	--	--	--	--	--
P to Burner #1 GAS	--	4.2	4.2	5.0	5.0
P to Burner #2 "	--	--	5.0	2.0	2.0
P to Burner #3 "	--	--	2.0	5.0	4.4
P to Burner #4 "	--	--	5.4	6.8	6.4
P to Burner #5 "	--	--	6.6	4.2	4.2
P to Burner #6 "	--	--	4.2	4.0	4.0
Air Registers (%open)	50	--	--	--	--
Crude API Gravity	22.5	22.5	22.5	22.5	22.5
Flame Observations	--	--	--	--	--
Tube 13 Pass A	710	763	765	766	762
Tube 13 Pass B	775	775	772	767	770
Tube 15 Pass A	735	733	736	739	732
Tube 15 Pass B	575	710	625	740	725

UNIT OPERATING DATA - CONTINUED

Test No. 1 Date 18 JUNE, 1981 Location TOSCO Engr. R. DEROSIER

Unit No. 11H13 Fuel Capacity 16250 bbl/d, 55 x 10^6 Btu/h

Unit Type CRUDE HEATER Burner Type JOHN ZINK DBA-22

Test Description:

Tube 20 Pass A	745	746	746	750	745
Tube 20 Pass B	775	778	775	775	776
Tube 25 Pass A	778	775	776	778	780
Tube 25 Pass B (outlet)	780	785	781	787	788
Stack	725	724	725	720	720
Gas Pressure to Heater					

UNIT OPERATING DATA

Test No. 1 Date 18 JUNE, 1981 Location TOSCO Engr. R. DEROSIER

Unit No. 11H13 Fuel Oil/GAS Capacity 16250 bbl/d, 55x10^6 Btu/h

Unit Type CRUDE HEATER Burner Type JOHN ZINK DBA-22

Test Description:

Test number		1				
Time		5:50	6:50	7:50	8:50	
Process Rate x 1847.7 bbl/d		6.3	6.3	6.3	6.3	
Crude Tin (°F)		388	383	383	383	
Crude Tout (°F) East		635	642	643	643	
Crude Tout (°F) West		635	638	636	632	
Crude Pin (psig) East		140	140	140	140	
Crude Pin (psig) West		130	130	130	130	
Crude Pout (psig)		32	33	33	33	
Reabsorber gas in x 205.856 (10^3 scf/d)		2.4	2.0	2.2	2.2	
Burner #1	Oil P/Steam P (psig)	52/80	50/80	52/80	50/80	
Burner #2		43/81	44/80	43/80	43/81	
Burner #3		--	--	--	--	
Burner #4		48/75	48/76	48/76	48/76	
Burner #5		44/77	46/78	46/77	47/78	
Burner #6		--	--	--	--	
P to Burner #1	Gas P (psig)	5.0	3.6	4.0	4.2	
P to Burner #2		6.0	4.0	5.0	5.0	
P to Burner #3		2.2	2.0	1.8	2.0	
P to Burner #4		4.4	4.2	3.8	3.6	
P to Burner #5		8.0	6.2	6.7	6.9	
P to Burner #6		48	4.9	4.2	4.2	
Air Registers (%open)		50	--	--	--	
Crude API Gravity		22.5	--	--	--	
Flame Observations		--	--	--	--	
Tube 13 Pass A		760	765	765	762	
Tube 13 Pass B		765	770	768	715	
Tube 15 Pass A		732	735	735	735	
Tube 15 Pass B		720	750	755	740	

UNIT OPERATING DATA - CONTINUED

Test No. 1 Date 18 JUNE, 1981 Location TOSCO Engr. R. DEROSIER

Unit No. 11H13 Fuel O·l GAS Capacity 16250 bbl/d, 55×10^6 Btu/h

Unit Type CRUDE HEATER Burner Type JOHN ZINK DBA -22

Test Description:

Tube 20 Pass A	745	747	745	744	
Tube 20 Pass B	746	780	780	766	
Tube 25 Pass A	774	780	776	723	
Tube 25 Pass B (outlet)	733	790	792	785	
Stack	717	745	724	725	
Gas Pressure to Heater	37.5	31	33	34	

UNIT OPERATING DATA

Test No. 2 Date 19 June, 1981 Location Tosco Engr. R. Derosier

Unit No. 11H13 Fuel Oil/Gas Capacity 16250 bbl/d, 55 x 10⁶ Btu/h

Unit Type Crude Heater Burner Type John Zink DBA-22

Test Description: Low-NOx - using KUB lance

Test number		2				
Time		10:00	11:00	12:00	1:00	2:00
Process Rate x 1847.7 bbl/d		6.3	6.3	6.3	6.3	6.3
Crude Tin (°F)		385	383	384	384	384
Crude Tout (°F) East		643	645	642	644	639
Crude Tout (°F) West		639	644	642	646	641
Crude Pin (psig) East		140	140	140	140	140
Crude Pin (psig) West		130	130	130	130	130
Crude Pout (psig)		34	35	35	33	35
Reabsorber gas in x 205.856 (10^3 scf/d)		2.2	2.1	2.1	2.1	2.0
Burner #1		50/80	50/80	50/80	50/80	52/80
Burner #2		44/80	42/80	43/80	43/80	44/80
Burner #3	Oil P/Steam P	--	--	--	--	--
Burner #4	(psig)	48/74	48/75	49/76	49/75	48/76
Burner #5		47/78	46/77	46/78	42/77	44/78
Burner #6		--	--	--	--	--
P to Burner #1		4.1	4.4	4.4	4.4	4.0
P to Burner #2		5.5	5.5	6.0	5.5	5.0
P to Burner #3	Gas P	2.0	2.0	2.0	2.0	2.0
P to Burner #4	(psig)	2.8	2.8	3.2	3.2	2.8
P to Burner #5		7.9	7.0	7.2	7.0	6.8
P to Burner #6		4.1	4.2	4.2	4.0	4.0
Air Registers (%open)		--	--	--	--	--
Crude API Gravity		23.0	23.0	23.0	23.0	23.0
Flame Observations		--	--	--	--	--
Tube 13 Pass A		756	767	760	767	757
Tube 13 Pass B		750	740	741	746	741
Tube 15 Pass A		726	729	731	734	728
Tube 15 Pass B		714	700	705	705	703

UNIT OPERATING DATA - CONTINUED

Test No. 2 Date 19 June 1981 Location Tosco Engr. K Derosier

Unit No. 11H13 Fuel ________ Capacity 16250 bbl/d, 55×10^6 Btu/h

Unit Type Crude Heater Burner Type John Zink DBA-22

Test Description: Low-NOx Using KVB Lance

Tube 20 Pass A	741	741	744	745	740
Tube 20 Pass B	750	740	743	744	740
Tube 25 Pass A	763	762	761	767	758
Tube 25 Pass B (outlet)	770	765	765	769	765
Stack	743	714	713	714	710
Gas Pressure to Heater	35	35.5	36	35.5	34.5

UNIT OPERATING DATA

Test No. 2 Date 19, JUNE 1981 Location TOSCO Engr. R. DEROSIER

Unit No. 11H13 Fuel

Capacity 16250 bbl/d, 55x10^6 Btu/h

Unit Type CRUDE HEATER Burner Type JOHN ZINK DBA-22

Test Description: LOW NOX

Test number		2	--	--	--	
Time		3:45	--	--	--	
Process Rate x 1847.7 bbl/d		6.3	--	--	--	
Crude Tin (°F)		386	--	--	--	
Crude Tout (°F)East		638	--	--	--	
Crude Tout (°F) West		640	--	--	--	
Crude Pin (psig) East		140	--	--	--	
Crude Pin (psig) West		130	--	--	--	
Crude Pout (psig)		34.5	--	--	--	
Reabsorber gas in x 205.856 (10^3 scf/d)		2.1	--	--	--	
Burner #1		51/80	--	--	--	
Burner #2		43/81	--	--	--	
Burner #3	Oil P/Steam P	--	--	--	--	
Burner #4	(psig)	49/77	--	--	--	
Burner #5		48/77	--	--	--	
Burner #6		--	--	--	--	
P to Burner #1		4.2	--	--	--	
P to Burner #2		5.0	--	--	--	
P to Burner #3	Gas P	2.0	--	--	--	
P to Burner #4	(psig)	3.0	--	--	--	
P to Burner #5		6.6	--	--	--	
P to Burner #6		4.0	--	--	--	
Air Registers (%open)		--	--	--	--	
Crude API Gravity		23.0	--	--	--	
Flame Observations		--	--	--	--	
Tube 13 Pass A		757	--	--	--	
Tube 13 Pass B		738	--	--	--	
Tube 15 Pass A		723	--	--	--	
Tube 15 Pass B		700	--	--	--	

UNIT OPERATING DATA - CONTINUED

Test No. 2 Date 19 JUNE 1981 Location TOSCO Engr. R. DEROSIER

Unit No. 11H13 Fuel Capacity 16250 bbl/d, 55x10⁶ Btu/h

Unit Type CRUDE HEATER Burner Type JOHN ZINK DBA-22

Test Description: LOW NOx

Tube 20 Pass A	744	--	--	--	
Tube 20 Pass B	739	--	--	--	
Tube 25 Pass A	761	--	--	--	
Tube 25 Pass B (outlet)	762	--	--	--	
Stack	708	--	--	--	
Gas Pressure to Heater	34.5				

Note --

1. Gas flowmeter dropped from 3.3 to 2.1 (x205856 scfd) when cofiring with oil commenced.

2. During previous testing, KVB found the gas flowmeter to be reading high. A correction factor of 0.83 should thus be applied to all readings.

SECTION 4

SAMPLING DATA SHEETS

4.1 KVB Continuous Emissions Monitoring Report

4.2 Operating Data Tables for EPA Method 5

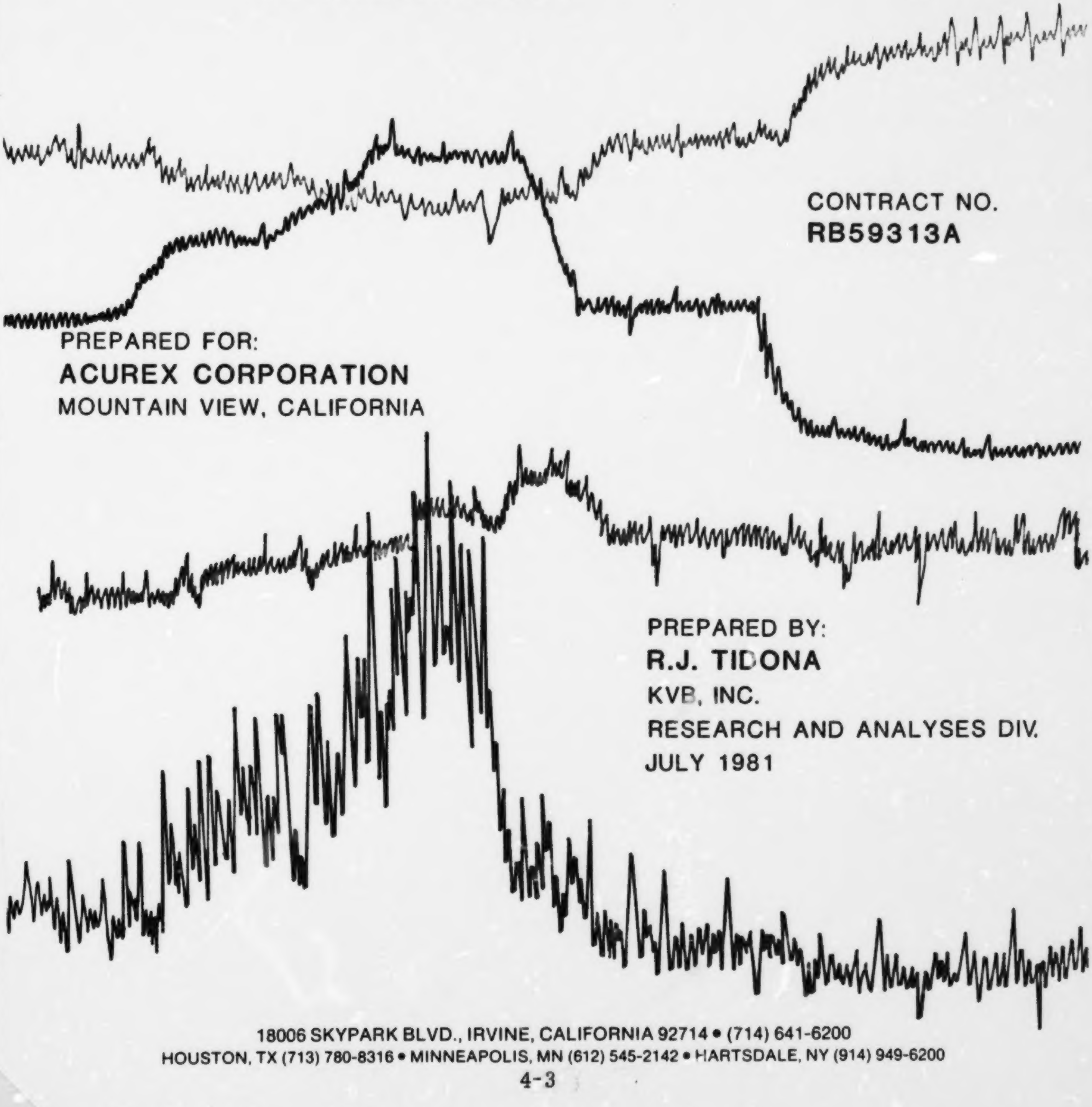
4.3 Operating Data Tables for Controlled Condensation Train

4.4 Operating Data Tables for SASS

4.1 KVB CONTINUOUS EMISSIONS MONITORING REPORT

NOx EMISSIONS ASSESSMENT: GASEOUS EMISSIONS FROM A REFINERY PROCESS HEATER IN BASELINE AND LOW-NOx CONFIGURATIONS

KVB11 47800-1284



CONTRACT NO.
RB59313A

PREPARED FOR:
ACUREX CORPORATION
MOUNTAIN VIEW, CALIFORNIA

PREPARED BY:
R.J. TIDONA
KVB, INC.
RESEARCH AND ANALYSES DIV.
JULY 1981

18006 SKYPARK BLVD., IRVINE, CALIFORNIA 92714 • (714) 641-6200
HOUSTON, TX (713) 780-8316 • MINNEAPOLIS, MN (612) 545-2142 • HARTSDALE, NY (914) 949-6200

ABSTRACT

Gaseous emissions were measured on a natural draft refinery process heater in support of NO_x emissions assessment testing by Acurex Corporation. Species measured continuously by KVB were NO, CO, CO_2, O_2, and SO_2. Two test configurations, baseline and low-NO_x, were tested at a process rate of 77.11 m^3/h (11,640 bbl/d) of crude feed. A mixture of refinery gas and No. 6 oil was fired for both tests. The low-NO_x configuration was obtained by staging approximately one-third of the total combustion air. The staged air was introduced through twenty-four lances (four per burner) at a height of 1.2m (4 ft) above the fuel injection plane. The average baseline NO emission was 172 ppm, dry at 3 percent O_2. At the low-NO_x conditions the average NO emissions dropped to 118 ppm, dry at 3 percent O_2 for a reduction of 31.4 percent. This result was in accordance with expectations based on previous tests taking into account differences in the relative proportions of No. 6 oil and refinery gas fired in the present tests. Emissions of the other continuously measured gaseous species at low-NO_x conditions were largely unchanged from their baseline levels.

CONTENTS

Section		Page
	ABSTRACT	4-4
1.0	DESCRIPTION OF TESTS	4-6
2.0	GASEOUS EMISSIONS TEST METHODS AND INSTRUMENTATION	4-8
3.0	PRESENT TEST RESULTS	4-11
4.0	CONCLUSIONS	4-14

APPENDICES:

A. GASEOUS EMISSIONS MEASUREMENTS TAKEN DURING SASS TESTS AT REFINERY PROCESS HEATER 4-15

SECTION 1.0

DESCRIPTION OF TESTS

KVB participated as a subcontractor to Acurex Corporation in the NO_x Emissions Assessment program (Contract No. RB59313A) at a refinery process heater from June 15, 1981 through June 19, 1981. During the test period KVB was responsible for continuously measuring NO_x, CO, CO_2, O_2, and SO_2 gaseous emissions. The emissions were measured on a natural draft refinery process heater firing a mixture of approximately one-third No. 6 oil (by heat input) and two-thirds refinery gas. The heater was equipped with staged air lances. One baseline test was conducted without staged combustion air and a second low-NO_x test was run with maximum staging at about the same or a slightly lower level of excess oxygen. Concurrent SASS, EPA Method 5, and wet chemical SO_x tests were run by Acurex Corporation.

Originally, plans had been made to operate the heater with a 50/50 mixture of gas and oil, however, the plant was unable to flare enough fuel gas to allow that much fuel oil to be burned. This situation occurs frequently during the summer when process offgases are more abundant. In addition, two oil guns were plugged during the tests. Due to scheduling problems with the plant maintenance department, the guns could not be cleaned in time to allow both SASS tests to be completed in the allotted time. It was nevertheless felt that the tests should be conducted and that appropriate allowances for the effect of oil/gas ratio on emissions could be made.

It is also important to note that the excess O_2 level (~4 percent) maintained in the low-NO_x test was considered to be the lowest continuous operating level by the plant, although previous tests by KVB had shown the system to be capable of operating over a short-term at 2 percent O_2. Problems in maintaining adequate combustion air flow had occurred during a 30-day test conducted on the same heater previously firing 100 percent refinery gas when 2 percent O_2 was the target operating condition. After an incident in which the unit nearly went down because of air starvation, the plant decided to maintain 4 percent O_2 as the minimum operating level and this decision was carried over to the present tests with the oil/gas fuel combination. Thus, the NO_x reduction in the present low-NO_x test was due primarily to the staged air system. Lowered excess air was essentially not a factor in the NO_x reduction as it had been in some past tests.

SECTION 2.0

GASEOUS EMISSIONS TEST METHODS AND INSTRUMENTATION

All emission measurement instrumentation was carried in an 8 x 42 ft mobile laboratory trailer. The gaseous species measurements were made with analyzers located in the trailer.

The emission measurement instrumentation used was the following:

TABLE 1. EMISSION MEASUREMENT INSTRUMENTATION

Species	Manufacturer	Measurement Method	Model No
Carbon Monoxide	Beckman Instruments	IR Spectrometer	865
Oxygen	Teledyne	Polarographic	326A
Carbon Dioxide	Beckman Instruments	IR Spectrometer	864
Nitrogen Oxides	Thermo Electron Co.	Chemiluminescent	10A
Sulfur Dioxide	DuPont Instruments	UV Spectrometer	400

2.1 GAS SAMPLING AND CONDITIONING SYSTEM

A flow schematic of the flue gas sampling and analyzing system is shown in Figure 1. The sampling system uses one of three double-headed positive-displacement diaphragm pumps to continuously draw flue gas from the stack into the laboratory. The sample pumps pull from up to six unheated sample lines. Selector valves allow composites of up to six points to be sampled at one time. The probes are connected to the sample pumps with 0.95 cm (3/8") or 0.64 cm (1/4") nylon line. The positive displacement diaphragm sample pumps provide unheated sample gas to the refrigerated condenser (to reduce the dew point to 35°F), a rotameter with flow control valve, and to the O_2, NO, CO, and CO_2 instrumentation. Flow to the individual analyzers is measured and controlled with rotameters and flow control valves. Excess sample is vented to the atmosphere.

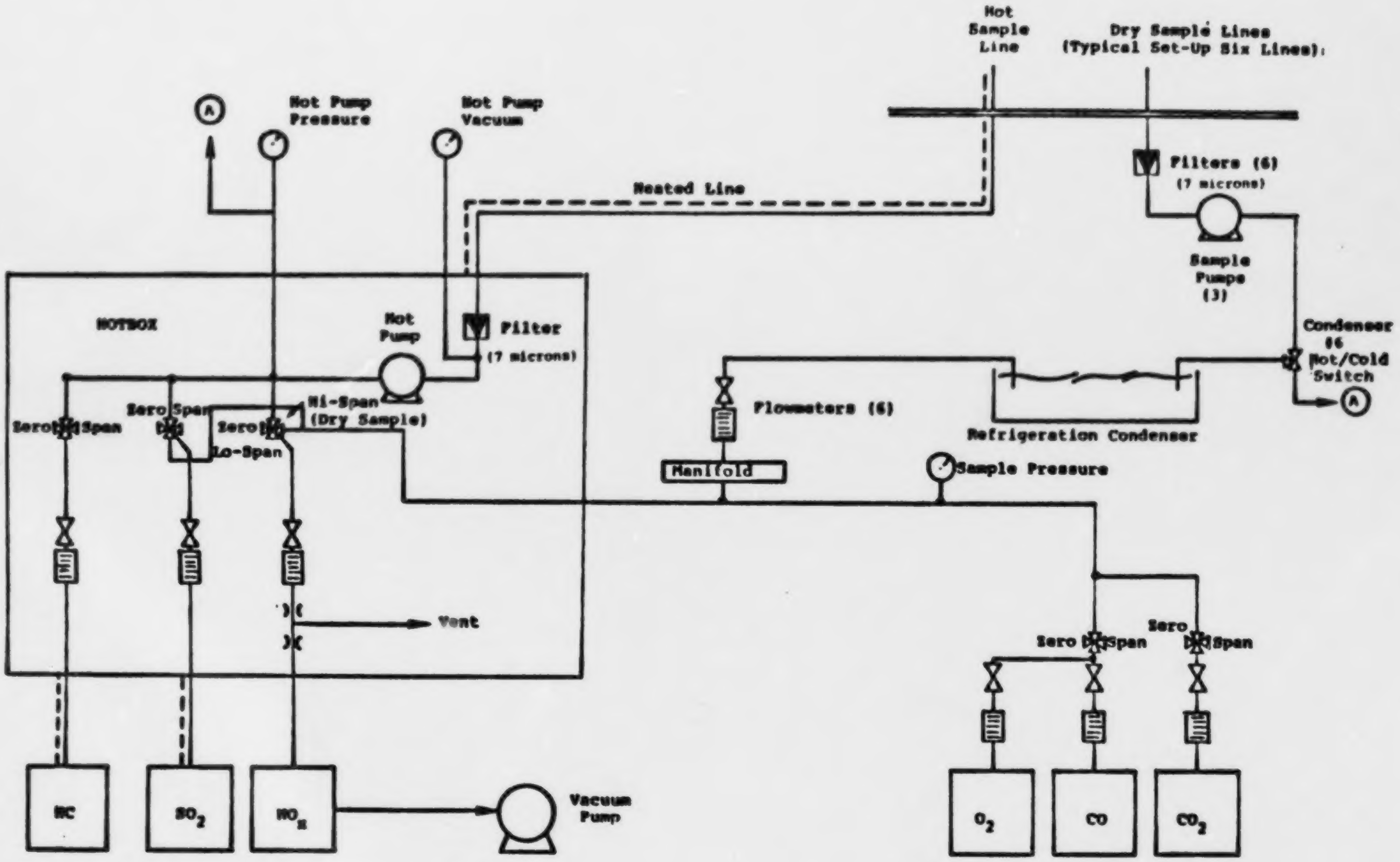

Hot Sample Line
Dry Sample Lines (Typical Set-Up Six Lines):
A
Hot Pump Pressure
Hot Pump Vacuum
Heated Line
Filters (6) (7 microns)
Sample Pumps (3)
HOTBOX
Hot Pump
Filter (7 microns)
Condenser & Hot/Cold Switch
A
Zero
Span
Zero
Span
Zero
Hi-Span (Dry Sample)
Lo-Span
Flowmeters (6)
Refrigeration Condenser
Manifold
Sample Pressure
Vent
Zero
Span
Zero
Span
HC
SO_2
NO_x
Vacuum Pump
O_2
CO
CO_2

Figure 1. Flue gas sampling and analyzing system.

To obtain a representative sample for the analysis of NO_2, SO_2 and hydrocarbons, the sample must be kept above its dew point, since heavy hydrocarbons may be condensible, and SO_2 and NO_2 are quite soluble in water. For this reason, a separate electrically heated sample line is used to bring the sample into the laboratory for analysis. The sample line is 0.95 cm (3/8-inch) Teflon line, electrically traced and thermally insulated to maintain a sample temperature of up to 400°F. A heated diaphragm pump provides hot sample gas to the hydrocarbon, SO_2 and NO_x analyzers and cold, dried gas to the other continuous analyzers via the condenser described above.

The laboratory trailer is equipped with the analytical instruments shown in Table 1 to continuously measure concentrations of NO, NO_2, CO, CO_2, O_2, SO_2, and hydrocarbons. All of the continuous monitoring instruments and sample handling system are mounted in the self-contained mobile laboratory. The instruments themselves are shock mounted on a metal console panel. The sample flow control measurement, and selection, together with instrument calibration are all performed from the console face. Three-pen recorders provide a continuous permanent record of the data taken. The sample gas is delivered to the analyzers at the proper condition and flow rate through the sampling and conditioning system described previously. A Monitor Laboratories Model 9300 Data Logger is normally used to record and average data from the analyzers and can be coupled with a Techtran Model 815 Datacassette recorder to provide digital storage of the data.

SECTION 3.0

PRESENT TEST RESULTS

The test unit was first run at a baseline operating condition at a process rate of 77.11 m^3/h (11,640 bbl/d) of crude throughput. A sketch of the unit is shown in Figure 2. The secondary air registers were approximately 40 percent open and the excess oxygen at the stack was maintained at approximately four percent. For this baseline test the ratio of oil/gas by heat input was 37/63.

The gaseous emission measurements were taken by means of a single probe and heated sample line from the stack approximately five feet above the outlet of the transition section for both the baseline and the low-NO_x test which followed. Dry measurements of CO, CO_2, NO, and O_2 were made while a wet measurement was taken for SO_2.

The low-NO_x configuration on this process heater was achieved by means of staged air lances inserted through the heater floor. Roughly one-third of the total combustion air was introduced through the lances. This was the maximum staging capability of the system. An excess oxygen level of approximately 3-4 percent was maintained and the secondary air registers were adjusted to ten percent open as in previous tests conducted by KVB. The process rate was again 77.11 m^3/hr of crude oil, but the oil/gas ratio changed slightly to 31/69.

(All numbers given for the operating parameters are approximate daily averages.)

The table below summarizes the emissions measured and the standard deviation in the emission measurements along with the range of values and number of measurements taken for both the baseline and the low-NO_x tests. SO_2 measurements are reported as wet values at measured excess O_2. The values for NO emissions are reported as dry at measured excess O_2. The average NO emissions were corrected to 3 percent O_2 using that average O_2 concentration

NATURAL DRAFT REFINERY PROCESS HEATER

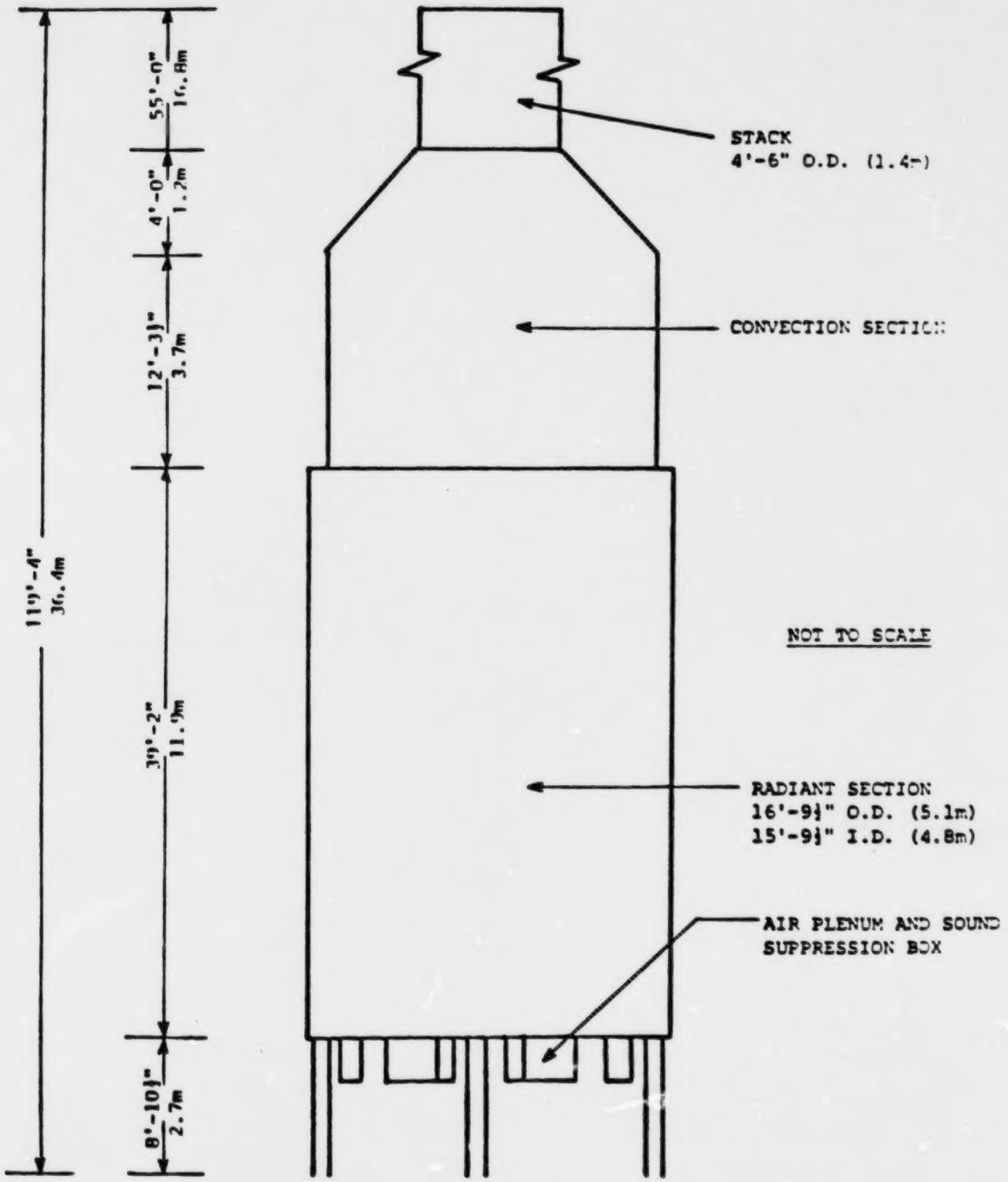

55'-0"
16.8m
4'-0"
1.2m
12'-3½"
3.7m
39'-2"
11.9m
8'-10½"
2.7m
119'-4"
36.4m
STACK
4'-6" O.D. (1.4m)
CONVECTION SECTION
NOT TO SCALE
RADIANT SECTION
16'-9½" O.D. (5.1m)
15'-9½" I.D. (4.8m)
AIR PLENUM AND SOUND
SUPPRESSION BOX

Figure 2. Sketch of the process heater tested.

both tests. The gaseous emission measurements were 15 minute averages as determined by manually interpreting the strip chart recordings for each analyzer. This procedure was made necessary by the failure of the electronic data logger just prior to the start of the tests.

TABLE 2. SUMMARY OF GASEOUS EMISSIONS DATA FROM REFINERY PROCESS HEATER SASS TESTS

	Baseline Test				Low NO_x Test			
Species	$\overline{C}$	s	C_{min}/ C_{max}	n	$\overline{C}$	s	C_{min}/ C_{max}	n
O_2 (%, dry)	4.0	0.20	3.3/4.3	37	3.3	0.27	3.1/4.2	20
CO_2 (%, dry)	12.1	0.87	10.5/13.6	33	11.7	0.32	11.3/12.4	17
CO (ppm, dry)	3.8	2.9	0/10	38	7.3	3.4	0/10	20
SO_2 (ppm,wet)	151	11.6	120/170	21	148	11.4	125/170	20
NO (ppm, dry)	162	6.0	152/174	37	116	3.8	108/125	20
NO (ppm, dry at 3% O_2)	172	--	156/186	--	118	--	109/134	--

$$\%NO \text{ reduction in low-}NO_x\text{ configuration} = \frac{172 - 118}{172} \times 100 = 31.4\%$$

The complete set of gaseous emission measurements is given in the Appendix. No significant NO_2 was measured during either test.

SECTION 4.0

CONCLUSIONS

The data show that an average NO emission reduction of 31.4 percent from the baseline emission of 172 ppm, dry at three percent O_2, was obtained in the low-NO_x configuration. The CO emissions remained very low in both tests. The high standard deviations reflect the fact that the CO levels were at the lower limits of detectability of the CO analyzer being used. SO_2 emissions were approximately the same in both baseline and low-NO_x configurations.

The percent reduction in NO emissions due to the staged air system was approximately the same as the reduction observed in previous tests when firing a 50/50 mixture of oil and gas fuels under roughly the same operating conditions. In those previous tests the heater process rate was 78.3 m^3/h (11,800 bbl/d) and the overall excess O_2 was about 4 percent. In those tests, however, the baseline NO emission was 207 ppm, dry at three percent O_2.

The difference in baseline NO emissions between the present tests and the past tests is due to the difference in oil/gas ratio. From previous tests, it is known that the thermal NO_x alone at baseline conditions is about 125 ppm, dry at 3 percent oxygen. The baseline level of 172 ppm in the present tests for a 37/63 oil/gas mixture represents a 47 ppm increment above this emission level. One may predict an emission level for the 50/50 oil/gas mixture as follows (assuming a constant fuel nitrogen conversion efficiency):

$$\left(\frac{50}{37} \times 47\right) + 125 = 189 \text{ ppm}$$

This value is within 10 percent of the observed value of 207 ppm.

APPENDIX A

GASEOUS EMISSIONS MEASUREMENTS TAKEN DURING SASS TESTS AT REFINERY PROCESS HEATER

BASELINE
SASS TEST I - 6-18-81
FROHOFF

Date	Time	NO ppm	O_2 Percent	CO_2 Percent	CO ppm	Load x 1000	~~Comment Codes~~ SO_2 ppm
	0615						
	0630						
	0645						
	0700						
	0715						
	0730						
	0745						
	0800						
	0815						
	0830						
	0845						
	0900						
	0915						
	0930						
	0945						
	1000						
	1015						
	1030						
	1045						
	1100						
	1115						
	1130						
	1145	START	OF SASS	TEST	12:00		
	1200	162	4.2	13.6	10		148

BASELINE
SASS TEST I - 6-18-81
FROHOFF

KVB

Date	Time	NO ppm	O_2 Percent	CO_2 Percent	CO ppm	Load x 1000	SO_2 ppm ~~Comment Codes~~
	1215	163	4.2	12.9	5		144
	1230	164	4.2	13.0	5		130
	1245	159	4.0	12.5	5		120
	1300	162	4.1	12.5	5		00S
	1315	170	4.2	12.5	5		00S
	1330	169	4.3	12.8	5		00S
	1345	167	4.1	13.3	5		00S
	1400	168	4.1	13.6	5		00S
	1415	170	4.2	13.3	5		00S
	1430	172	4.2	13.3	5		00S
	1445	174	4.2	13.3	5		00S
	1500	173	4.3	12.8	5		00S
	1515	Calibrate	4.1	12.8	5		00S
	1530	162	Calibrate	12.5	5		00S
	1545	162	4.0	Calibrate	5		Calibrate
	1600	163	3.9	11.7	5		Cal
	1615	163	3.9	11.7	5		Cal
	1630	163	4.0	11.7	5		Cal
	1645	164	4.0	11.7	5		Cal
	1700	164	3.9	11.6	5		Cal
	1715	157	CAlibrate	11.3	Calibrate		Cal
	1730	160	3.8	Calibrate	5		170
	1745	CAlibrate	3.9	11.3	5		160
	1800	170	4.2	10.5	10		170

BASELINE
SASS TEST I 6-18-81
FROHOFF

Reproduced from best available copy.

SO_2 ppm

Date	Time	NO ppm	O_2 Percent	CO_2 Percent	CO ppm	Load x 1000	Comment Codes
6-18	1815	170	4.2	11.0	5		150
	1830	153	3.3	11.5	0		140
	1845	156	3.7	11.0	0		140
	1900	Calibrate	Calibrate	Calibrate	Cal		Cal
	1915	156	3.8	12.0	10		155
	1930	160	3.9	11.7	0		155
	1945	158	3.8	11.3	0		155
	2000	159	3.9	11.3/Cal	0		155
	2015	157	3.8	11.7	0		155
	2030	158	3.8	11.7	0		155
	2045	158	4.0	11.0	0		155
	2100	157	4.1	—	0		155
	2115	155	4.1	Cal	0		155
	2130	153	3.9	—	0		155
	2145	152	4.0	—	0		155
	2200	——	END SASS TEST I				
	2215						
	2230						
	2245						
	2300						
	2315						
	2330						
	2345						
	2400						

Sass TEST II
Low NO_x - 6-19-81
FROHOFF - HTR 11 H13

KVB

Date	Time	NO ppm	O_2 Percent	CO_2 Percent	CO ppm	Load x 1000	~~Comment Codes~~ SO_2 ppm
	0615						
	0630						
	0645						
	0700						
	0715						
	0730						
	0745						
	0800						
	0815						
	0830						
	0845						
	0900						
	0915						
	0930						
	0945	SASS TEST # II STARTED 10:00					
	1000						
	1015			CALIBRATE			
	1030			Calibrate			
	1045	125	4.2	11.3	0		145
	1100	120	3.9	11.3	0		145
	1115	116	3.5	11.7	5		145
	1130	114	3.4	11.7	5		145
	1145	117	3.4	11.7	10		140
	1200	118	3.4	11.7	10		130

Note* DATA POINTS ARE AVERAGES OF PREVIOUS 15 MINUTES OF DATA

Sass TEST # II
Low NOx - 6-19-81
FROHOFF HTR 11H13

KVB

Date	Time	NO ppm	O_2 Percent	CO_2 Percent	CO ppm	Load x 1000	~~Comment Codes~~ SO_2 ppm
6-19	1215	115	3.2	11.9	5		125
	1230			CALIBRATE			
	1245	110	3.1	12.4	10		160
	1300	108	3.1	12.4	10		160
	1315	112	3.2	11.9	10		160
	1330	112	3.2	11.9	10		150
	1345	117	3.2	11.7	5		150
	1400	119	3.3	11.3	5		140
	1415	117	3.2	11.5	5		140
	1430	118	3.3	11.9	5		135
	1445			CALIBRATE			
	1500	117	3.2	—	10		170
	1515	118	3.2	—	10		160
	1530	118	3.2	Calibrate	10		160
	1545	118	3.2	11.7	10		150
	1600	119	3.2	11.7	10		150
	1615						
	1630						
	1645						
	1700						
	1715						
	1730						
	1745						
	1800						

NOTE * DATA POINTS ARE AVERAGES OF PREVIOUS 15 MINUTES OF DATA

4.2 OPERATING DATA FOR EPA METHOD 5

TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

PLANT TOSCO
DATE 6/18/81
SAMPLING LOCATION stack
INSIDE OF FAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE A) ~~57~~" 58.5"
INSIDE OF NEAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE B) 12"
STACK I.D., (DISTANCE A - DISTANCE B) ~~49~~" 46.5"
NEAREST UPSTREAM DISTURBANCE Stack exit 7 2 0
NEAREST DOWNSTREAM DISTURBANCE top of heater 4.96 0
CALCULATOR Steiner

* adjust to 1" from stack wall

SCHEMATIC OF SAMPLING LOCATION

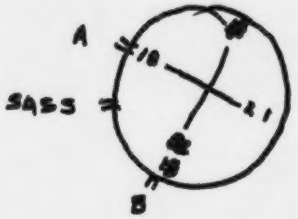
TRAVERSE POINT NUMBER	FRACTION OF STACK I.D.	STACK I.D.	PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1/8 INCH)	DISTANCE B	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF COLUMNS 4 & 5)
1	0.014	~~49~~ 46.5	0.69* .65*	12	13* 13.00
2	0.044	49	2.16 2.05	12	14.16 14.05
3	0.075	49	3.68 3.49	12	15.68 15.49
4	0.109	49	5.34 5.07	12	17.34 17.07
5	0.146	49	7.15 6.79	12	19.15 18.79
6	0.188	49	9.21 8.74	12	21.21 20.74
7	0.236	49	11.56 10.97	12	23.56 22.97
8	0.296	49	14.50 13.76	12	26.50 25.76
9	0.382	49	18.71 17.76	12	30.71 29.76
10	0.618	49	30.28 28.73	12	42.28 40.73
11	0.704	49	34.50 32.74	12	46.50 44.74
12	0.764	49	37.43 35.53	12	49.43 47.53
13	0.812	49	39.79 37.76	12	51.79 49.76
14	0.854	49	41.85 39.71	12	53.85 51.71
15	0.891	49	43.66 41.43	12	55.66 53.43
16	0.925	49	45.33 43.01	12	57.33 55.01
17	0.956	49	46.84 44.45	12	58.84 56.45
18	0.986	49	48.31 * 45.85*	12	60* 57.00

EPA (Dur) 232
4/72

1000.85

PRELIMINARY VELOCITY TRAVERSE

PLANT TOSCO
DATE 6/18/
LOCATION Stack
STACK I.D. 46.5"
BAROMETRIC PRESSURE, in. Hg 29.42
STACK GAUGE PRESSURE, in. H_2O - 0.31
OPERATORS Steiner / Sniffen



SCHEMATIC OF TRAVERSE POINT LAYOUT

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
A-1	0.10	708
2	0.10	708
3	0.10	704
4	0.10	704
5	0.10	703
6	0.09	705
7	0.09	706
8	0.09	706
9	0.09	706
10	0.08	704
11	0.08	706
12	0.08	705
13	0.07	704
14	0.07	702
15	0.06	694
16	0.06	235 *
17	0.04	191 *
18	0.04	191 *
pts A 1-15	=	704.3 °F
AVERAGE	0.08	708 °F

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
B-1	0.09	692
2	0.09	692
3	0.09	694
4	0.09	701
5	0.09	700
6	0.08	701
7	0.08	708
8	0.08	708
9	0.07	708
10	0.08	708
11	0.08	709
12	0.08	704
13	0.08	704
14	0.08	704
15	0.08	702
16	0.07	684
17	0.06	570
18	0.06	570
pts B 1-15	=	686.61 °F
AVERAGE	.079	701.2

EPA (Dur) 233
4/72

*NOT USED

DRY MOLECULAR WEIGHT DETERMINATION

PLANT TOSCO
DATE 6/18/81
SAMPLING TIME (24-hr CLOCK) 8:07 am
SAMPLING LOCATION stack
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS GRAB) Fyrite, grab
ANALYTICAL METHOD
AMBIENT TEMPERATURE 75°F
OPERATOR Holm

COMMENTS:

GAS \ RUN	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2		12		12		11.5	12.83	44/100	5.21
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)		4.5		4.5		5.0	4.66	32/100	1.49
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)							0	28/100	0
N_2 (NET IS 100 MINUS ACTUAL CO READING)							83.51	28/100	23.38
								TOTAL	30.08

EPA (Dur) 230
4.72

ISOKINECTIC SAMPLING WORKSHEET

Plant TOSCO Peformed by Steiner
Date 6/18/81
Sample Location Stack
Test No./Type M5 #1

$$K = \frac{782.687\ (Cp)^2\ (1-B_{wo})^2\ P_s\ M_d}{K_o^2\ M_s\ P_m}$$

where: K = Contant of fixed and assumed parameters (dimensionless)

Test 2				
0.84	Pitot coefficient (dimensionless)	C_p	0.84	
0.1357	Water vapor in the gas stream (proportion by volume)	B_{wo}	0.12	assumed 50% o/g
29.37	Absolute stack gas pressure (in. Hg)	P_s	29.39	
30.07	Molecular weight, stack gas dry (lb/lb-mole)	M_d	30.07	
.6697	Orifice coefficient (dimensionless)	K_o	0.6697	
28.43	Molecular weight, stack gas wet (lb/lb-mole) $M_d(1-B_{wo}) + 18(B_{wo})$	M_s	28.62	
29.40	Abolute meter pressure (in. Hg)	P_m	29.42	
971.91	$\frac{782.687\ (.84)^2\ (1-.12)^2\ (29.39)\ (30.07)}{(.6697)^2\ (28.62)\ (29.42)}$	K	1000.85	

ISOKINECTIC NOZZLE CALCULATION
AND
SAMPLING RATE CALCULATION

Plant TOSCO Performed by Steiner

Date 6/18/81

Sample Location Stack

Test No./Type M5 #1

$$N_d = \left(\frac{\Delta H\ T_s}{K\ T_m\ \Delta P}\right)^{.25}$$

where: N_d = Nozzel diameter (inches)

			Test 2
Average pressure differential across the orifice meter (in. H_2O)	ΔH	1.2	1.2
Temperature stack gas, average (^oF)	T_s	700	740
Temperature of gas meter, average (^oF)	T_m	105	110
Stack gas velocity pressure (in H_2O)	ΔP	0.08	0.12
$\left(\frac{(1.2)\ (700 + 460)}{(1000.85)\ (105 + 460)(.08)}\right)^{.25}$	N_d	0.4188	.3836

$$\Delta H = K\ (N_d)^4\ \frac{T_m}{T_s}\ (\Delta P)$$

where: ΔH = Pressure differential across the orifice meter (in H_2O)

Nozzel diameter, actual (inches)	N_d	0.382	.382
Temperature of gas meter (^oF)	T_m		
Temperature of stack gas (^oF)	T_s		
Stack gas velocity pressure (in H_2O)	ΔP		
$\left((\_\_\_)\ (\_\_\_)^4\ \frac{(\_\_\_ + 460)}{(\_\_\_ + 460)}\ (\_\_\_)\right)$	ΔH		
Magic number $1000.85\ (.382)^4$	$K(N_d)^4$	21.31	20.69

Page 1 of 3

FIELD DATA

Plant TOSCO, BAKERSFIELD, CA
Date 6-18-81
Sample Location CRUDE HEATER
Sample Type M-5
Run Number 1
Operator J. STIENER / J. SNIFFEN
Ambient Temperature 75°F - 102°F
Barometric Pressure 29.42
Static Pressure, (H_2O) -0.31 in.
Filter Number(s) 96-34

Impinger Volumes

Initial	Final	Net Gain
100		
100	486.0	286.0
ø		
	Silica Gel	
250.0	340.2	90.2

SASS Condensate N/A
Total Volume 376.2

Probe Length and Type 5' - PYREX
Nozzel Size & I.D. .382 SN 907
Pitot Coefficient & I.D. .84
Assumed Moisture 12%
Molecular Weight, Dry, (M_d) 30.07
Meter Box Number
Meter Coefficient K_0 = 0.6699
α Factor 1.010
K = 1000.85
$K(Nd)^4 = 1000 \times (.382)^4 = 21.31$
$\Delta H = K(N_d)^4 \left(\frac{Tm}{Ts}\right)$ (P)

Leak Check: Initial at 16 " Hg, .002 CFM
Final at 14.5 " Hg, .002 CFM
Pitot Leak Check: ok

Traverse Point Number	Sampling Time, min / Clock Time (24-hr) Clock	Gas Meter Reading (V_m), ft 3	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), in. H_2O Desired	Orifice Pressure Differential (ΔH), in. H_2O Actual	Temperature °F Stack	Probe	Impinger	Organic Module	Oven	Gas Meter In	Gas Meter Out	Pump Vacuum in. Hg	Avg. $\sqrt{\Delta P}$
	4:43 PM	Init. 685.342												
B-1	0	687.825	0.13		1.31	732	250	96		270	110	110	6	.360
B-2	5	691.525	0.13		1.31	737	238	96		274	111	111	5	.360
B-3	10	694.575	0.13		1.32	737	330	96		246	112	111	5	.360
B-4	15	697.615	0.13		1.31	741	291	95		256	112	112	5	.360
B-5	20	700.685	0.13		1.32	741	282	97		251	112	111	5	.360
B-6	25	703.680	0.12		1.21	743	277	94		255	112	112	5	.346
B-7	30	706.650	0.12		1.22	741	269	93		252	112	112	5	.346
B-8	35	709.435	0.10		1.01	740	263	94		255	112	112	5	.316
B-9	40	712.150	0.09		0.91	745	257	95		257	112	112	4	.300

7602/5/81/Rev 1

813795

Comments: 5MIN/POINT

Page 2 of 3

Traverse Point Number	Sampling Time, min / Clock Time (24-hr) Clock	Gas Meter Reading (V_m), ft 3	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), in. H_2O		Temperature °F							Pump Vacuum in. Hg	Avg. $\sqrt{\Delta P}$
											Gas Meter			
		Init.		Desired	Actual	Stack	Probe	Impinger	Organic Module	Oven	In	Out		
B-10		714.620	0.09		0.91	739	258	94		250	112	112	4	.300
11		717.275	0.09		0.91	735	263	92		244	112	112	4	.300
12		719.730	0.09		0.91	742	248	89		264	111	111	4	.300
13		722.295	0.09		0.91	739	256	88		265	110	110	4	.300
14		724.870	0.09		0.91	736	262	89		255	110	110	4	.300
15		727.420	0.09		0.91	730	263	89		257	109	109	4	.300
16		730.000	0.09		0.92	716	264	90		262	110	110	4	.300
17		732.000	0.09		0.93	703	259	89		264	111	111	4	.300
18	6:13pm	735.174	0.09		0.94	697	259	88		262	111	111	4	.300
.		735.174												
A-1	6:28	738.210	0.14		1.31	745	259	91		267	113	113	5	.374
2		741.380	0.14		1.42	743	306	88		276	115	115	5	.374
3		744.575	0.14		1.42	746	310	89		286	115	115	6	.374
4		747.815	0.14		1.43	735	291	93		241	115	115	6	.374
5		750.950	0.13		1.32	745	277	94		249	114	114	6	.360
6		754.075	0.13		1.32	744	271	93		246	113	113	6	.360
7		757.180	0.13		1.31	750	271	92		259	113	113	6	.360

Run No. #1

Date 6/18/81

Sampling Location Stack

Comments:

Page 3 of 3

Traverse Point Number	Sampling Time, min / Clock Time (24-hr) Clock	Gas Meter Reading (V_m), ft 3		Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), in. H_2O		Temperature °F							Pump Vacuum in. Hg	Avg. $\sqrt{\Delta P}$
		Init.			Desired	Actual	Stack	Probe	Impinger	Organic Module	Oven	Gas Meter In	Gas Meter Out		
A-8		760.285		0.13		1.31	747	250	92		251	112	112	6	.360
9		763.190		0.11		1.11	746	256	90		253	112	111	6	.331
10		765.930		0.10		1.01	743	259	89		251	110	111	5	.316
11		768.655		0.10		1.00	746	250	85		274	110	110	4.5	.316
12		771.375		0.10		1.01	740	252	83		279	110	110	4.5	.316
13		774.215		0.11		1.11	741	248	83		262	110	110	4.5	.331
14		777.055		0.11		1.11	742	253	82		271	110	109	5.0	.331
15		779.900		0.11		1.11	738	259	82		270	110	109	5.0	.331
16		782.675		0.10		1.04	705	258	80		274	110	109	5.0	.316
17		785.630		0.10		1.36	430	256	81		259	110	109	6.0	.316
18	7:58 pm	789.326		0.10		1.99	250	248	80		269	110	109	6.0	.316
	180	103.984		.111		1.16	714.7					111.5	111.2		.332

111.35

Run No. #1

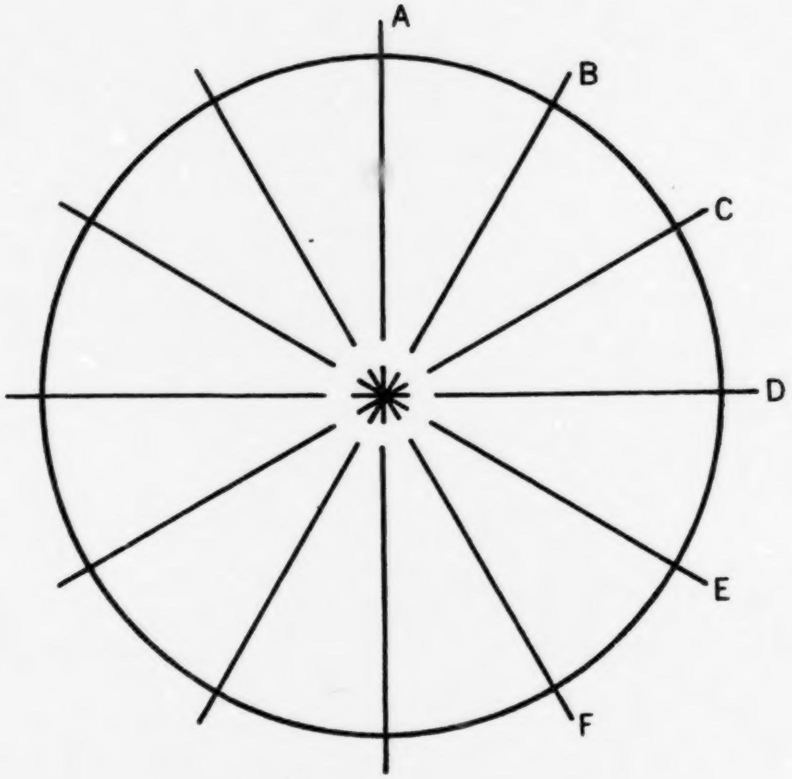
Date 6/18/81

Sampling Location stack

Comments:

ACUREX Corporation

NOZZLE MEASUREMENT



DIAMETER
DIMENSION
A .380
B .383
C
D .384
E .382
F .

AVG. .382

NOZZLE SERIAL
907

DATE
5/7/81

RECORDED BY
Sniff

FIELD DATA

Page 1 of 3

Plant TOSCO
Date 6/19/81
Sample Location Stack
Sample Type M5
Run Number 2
Operator Steiner/Smiffen
Ambient Temperature 75-100°F
Barometric Pressure 29.40
Static Pressure, (H_2O) -.31
Filter Number(s) 96-35

	Impinger Volumes Initial	Impinger Volumes Final	Net Gain
#1	100	361	261
#2	100	133	33
#3	0	5	5
	Silica Gel		
#4	250	318.7	68.7

SASS Condensate N/A
Total Volume 367.7

Probe Length and Type 5' glass
Nozzel Size & I.D. .382 SN907
Pitot Coefficient & I.D. .84
Assumed Moisture 0.1357 (13.57%)
Molecular Weight, Dry, (M_d) 30.07
Meter Box Number
Meter Coefficient 0.6697
α Factor 1.01
K = 971.91
$K(Nd)^4 = 971.91 \times (.382)^4 = 20.69$
$\Delta H = K(N_d)^4 \left(\frac{Tm}{Ts}\right) (P)$

Leak Check: Initial at 14 " Hg, .003 CFM
Final at " Hg, CFM
Pitot Leak Check: OK

Traverse Point Number	Sampling Time, min / Clock Time (24-hr) Clock	Gas Meter Reading (V_m), ft 3	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), in. H_2O Desired	Orifice Pressure Differential (ΔH), in. H_2O Actual	Temperature °F Stack	Temperature °F Probe	Temperature °F Impinger	Temperature °F Organic Module	Temperature °F Oven	Temperature °F Gas Meter In	Temperature °F Gas Meter Out	Pump Vacuum in. Hg	Avg. $\sqrt{\Delta P}$
	10:32 am	Init. 789.509												
A-1		792.670	0.14		1.37	733	244	83		241	105	103	2	.374
2		795.700	0.13		1.27	738	286	82		261	106	104	2	.360
3		798.735	0.13		1.26	741	277	83		268	107	104	2	.360
4		801.755	0.13		1.27	737	262	83		258	107	104	2	.360
5		804.670	0.12		1.17	739	265	82		267	107	104	2	.346
6		807.585	0.12		1.17	735	270	83		288	107	104	2	.346
7		810.380	0.11		1.07	740	281	85		290	107	104	2	.331
8		813.045	0.10		0.97	737	268	88		260	109	106	2	.316
9		815.685	0.10		0.97	740	254	88		267	109	106	2	.316

7602/5/81/Rev 1

Comments: 5 min/pt.

Page 2 of 3

Traverse Point Number	Clock Time (24-hr) Clock / Sampling Time, min	Gas Meter Reading (V_m), ft 3	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), in. H_2O		Temperature °F							Pump Vacuum in. Hg	Avg. $\sqrt{\Delta P}$
											Gas Meter			
		Init.		Desired	Actual	Stack	Probe	Impinger	Organic Module	Oven	In	Out		
A-10		818.245	0.09		0.88	728	250	88		254	110	107	2	.300
11		820.755	0.09		0.88	736	254	88		267	110	107	2	.300
12		823.285	0.09		0.88	732	253	88		268	111	107	2	.300
13		825.670	0.08		0.89	728	254	85		240	112	110	2.	.282
14		828.110	0.09		0.89	731	258	84		261	112	110	2	.300
15		830.665	0.09		0.90	714	262	85		254	112	110	2	.300
16		833.255	0.09		0.93	678	262	87		278	112	110	2	.300
17		836.625	0.09		0.96	641	263	89		267	113	111	2	.300
18 *	12:06	840.175	0.07		0.75	641	263	89		267	113	111	2	.264
		840.175												
B 1	12:20	843.042	0.12		1.19	728	228	94		278	118	116	2	.346
2		845.910	0.12		1.20	731	302	93		288	118	117	2	.346
3		848.880	0.12		1.20	727	285	96		271	118	117	2	.346
4		851,820	0.11		1.09	736	258	94		280	118	117	2	.331
5		854.675	0.11		1.10	734	286	93		278	118	116	2	.331
6		857.520	0.10		1.00	729	271	92		266	118	118	2	.316
7		860.240	0.10		1.00	735	261	92		272	117	115	2	.316

Run No. M5 #2

Date 6/19/81

Sampling Location Stack

Comments: * sampled A-18 for 9 mins instead of 5

Page 3 of 3

Traverse Point Number	Sampling Time, min / Clock Time (24-hr) Clock	Gas Meter Reading (V_m), ft 3		Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), in. H_2O		Temperature °F							Pump Vacuum in. Hg	Avg. $\sqrt{\Delta P}$
												Gas Meter			
		Init.			Desired	Actual	Stack	Probe	Impinger	Organic Module	Oven	In	Out		
A-8		862.925		0.08		0.79	736	267	94		271	117	116	2	.282
9		865.375		0.08		0.80	731	259	96		269	116	115	2	.282
10		867.790		0.08		0.80	731	254	95		254	117	116	2	.282
11		870.210		0.08		0.80	729	267	94		259	116	115	2	.282
12		872.650		0.08		0.80	722	277	98		252	117	115	2	.282
13		874.040		0.08		0.80	722	258	95		248	117	117	2	.282
14		877.490		0.08		0.80	721	252	92		250	116	115	2	.282
15		879.900		0.07		0.80	575	261	94		242	115	114	2	.264
16		882.325		0.06		0.79	440	261	94		240	115	114	2	.264
17		884.800		0.06		0.79	440	252	92		244	116	116	2	.264
18		887.149		0.06		.79	440	—	—		—	116	116	2	.264
	180	97.64				.97	696.6					113.11	111.31		11.117

112.21

$\frac{11.117}{36} = .309$

Run No. MS #2

Date 6-19-81

Sampling Location STACK

Comments:

4.3 OPERATING DATA FOR CONTROLLED CONDENSATION TRAIN

TOSCO, CCS Run 1 6-18-81 BAROS

CONTROLLED CONDENSATION SYSTEM (CCS)
FIELD CHECKPOINT SHEET

Checkpoint	Initials		Remarks
	Supervisor	QA Inspector	
LABORATORY PREPARATION			
• Inspect and clean CCC. Both filter holder and CCC are cleaned with hot chromic acid solution and D.I. H_2O.		✓	
• Rinse with acetone and air dry CCC.		✓	
• Place Tissuequartz filter in filter housing.		✓	
• Check seal between end of joint and filter.		✓	
• Do not use grease on joints.		✓	
• Inspect and clean all glass joints.		✓	
SITE SETUP			
• Rinse the inside of probe prior to run.		✓	
• Rinse probe with acetone until rinse solution is clear.		✓	
• Perform leak test.		✓	.0015 @ 21" Hg
• Leak rate must be less than 80 ml/min (0.003 cfm).		✓	
• Thermocouple leads attched to probe and filter.		✓	
• CCC water bath held at 60°C (140°F) ±1°C.		✓	
• Leak test train.		✓	
• Probe temperature maintained at 316°C (600°F) ±17°C.		✓	
• Gas temperature out of filter holder held at 228°C (550°F).		✓	
• Fresh solutions placed in impingers.		✓	
• Fresh absorbent replaced in final impinger.		✓	
• Adjust flowrate in system to 8 lpm.		✓	

TOSCO CCS Run 1 6-18-81 BHROS

CONTROLLED CONDENSATION SYSTEM (CCS)
FIELD CHECKPOINT SHEET -- Continued

Checkpoint	Initials		Remarks
	Supervisor	QA Inspector	
SAMPLING RUN • Turn vacuum pump on just before inserting probe in stack.		✓	
• Check seal between probe and port to prevent any outside air from entering stack.		✓	
• Run test for 1 hour or until coils are frosted to 1/2 or 2/3 their length.		✓	
• After run, cap both ends of probe and lay in horizontal position.		✓	
• Rinse the CCC coils into the modified Erlenmeyer flask with a maximum of 40 ml D.I. H_2O.		✓	
• Was any of the solution lost (0 ml estimated)?		✓	
• After probe has cooled, it is rinsed with a maximum of 40 ml D.I. H_2O into a 25-ml Erlenmeyer flask. - Was any solution lost (0 ml estimated)?		✓	
- Clean support equipment priot to next run.		✓	
- Save filter for titration.		✓	

Comments:

CONTROLLED CONDENSATION SYSTEM (CCS)
FIELD DATA SHEET

Plant TOSCO, BAKERSFIELD, CA
Date 6-18-81
Sample Location CRUDE HEATER
Run No. 1/ CCS
Operator B.C. DaRos

Ambient Temperature 104 °F
Barometric Pressure 29.42 @ 1530
Meter Box Number 084
Meter Orifice Coefficient .7024
Meter α Factor .998

Clock Time (24-hr) clock 1550 / Sampling Time, 0 min	Gas Meter Reading (V_m), ft^3	Temperature (^oF)							
	Init. 840.680	Stack	Probe 3	Filter		°C Recirc Water	Exit Coil 4	Dry Gas Meter	
				Skin 1	Out 2			In	Out
20 1600	845.510		543	1233	685	60	129	116	116
30 1610	848.010		560	1213	651	60	127	115	115
40 1620	850.900		561	1204	649	60	128	116	115
50 1630	853.800		564	1207	648	60	127	116	116
60 1640	856.500		569	1205	648	60	129	118	116
70 1650	859.940		570	1207	640	60	125	118	118
Average 70min	19.260	714.7 [1]	561.2	1211.5	653.5	60	127.5	116.3	

[1] From M-5 /Run No1 Data (average value)

TOSCO CCS RUN NO 2 6-19-81

CONTROLLED CONDENSATION SYSTEM (CCS)
FIELD CHECKPOINT SHEET

Checkpoint	Initials		Remarks
	Supervisor	QA Inspector	
LABORATORY PREPARATION			
• Inspect and clean CCC. Both filter holder and CCC are cleaned with hot chromic acid solution and D.I. H_2O.		✓	
• Rinse with acetone and air dry CCC.		✓	
• Place Tissuequartz filter in filter housing.		✓	
• Check seal between end of joint and filter.		✓	
• Do not use grease on joints.		✓	
• Inspect and clean all glass joints.		✓	
SITE SETUP			
• Rinse the inside of probe prior to run.		✓	
• Rinse probe with acetone until rinse solution is clear.		✓	
• Perform leak test.		✓	.0018 cfm @ 18" Hg
• Leak rate must be less than 80 ml/min (0.003 cfm).		✓	
• Thermocouple leads attched to probe and filter.		✓	
• CCC water bath held at 60°C (140°F) ±1°C.		✓	
• Leak test train.		✓	
• Probe temperature maintained at 316°C (600°F) ±17°C.		✓	
• Gas temperature out of filter holder held at 228°C (550°F).		✓	
• Fresh solutions placed in impingers.		✓	
• Fresh absorbent replaced in final impinger.		✓	
• Adjust flowrate in system to 8 lpm.		✓	

TOSCO CCS RUN No 2 6-19-81

CONTROLLED CONDENSATION SYSTEM (CCS)
FIELD CHECKPOINT SHEET -- Continued

Checkpoint	Initials		Remarks
	Supervisor	QA Inspector	
SAMPLING RUN • Turn vacuum pump on just before inserting probe in stack.		✓	
• Check seal between probe and port to prevent any outside air from entering stack.		✓	
• Run test for 1 hour or until coils are frosted to 1/2 or 2/3 their length.		✓	
• After run, cap both ends of probe and lay in horizontal position.		✓	
• Rinse the CCC coils into the modified Erlenmeyer flask with a maximum of 40 ml D.I. H_2O.		✓	
• Was any of the solution lost (0 ml estimated)?		✓	
• After probe has cooled, it is rinsed with a maximum of 40 ml D.I. H_2O into a 25-ml Erlenmeyer flask. - Was any solution lost (0 ml estimated)?		✓	
- Clean support equipment priot to next run.		✓	
- Save filter for titration.		✓	

Comments:

CONTROLLED CONDENSATION SYSTEM (CCS)
FIELD DATA SHEET

Plant TOSCO, BAKERSFIELD, CA

Date 6-19-81

Sample Location CRUDE HEATER

Run No. 2/CCS

Operator R.C. DaRos

Ambient Temperature 104°F

Barometric Pressure 29.40 "Hg.

Meter Box Number 084

Meter Orifice Coefficient .7024

Meter α Factor .998

Clock Time (24-hr) clock 1220 / Sampling Time, min 0	Gas Meter Reading (V_m), ft^3	Temperature (°F)							
				Filter		°C		Dry Gas Meter	
	Init. 860.800	Stack	Probe	Skin	Out	Recirc Water	Exit Coil	In	Out
10 / 1230	864.600		589	1278	655	60	132	114	112
20 / 1240	867.800		681	1371	693	60	132	114	113
30 / 1250	870.950		599	1266	687	60	132	114	113
40 / 1300	874.100		605	1222	649	60	133	114	113
50 / 1310	877.300		601	1223	649	60	133	114	113
60 / 1320	880.200		588	1220	647	60	133	114	113
70 / 1330	882.125		548	1216	640	60	133	114	113
Average 70. min	21.325	696.6[1]	601.6	1256.4	660.	60	132.5	113	.4

[1] From M-5 / Run No 2 Data (average T_s)

Reproduced from best available copy.

4.4 OPERATING DATA FOR SASS

ISOKINECTIC SAMPLING WORKSHEET

Plant TOSCO, BAKERSFIELD, CA   Peformed by J. HOLM
Date 6-19-81
Sample Location CRUDE HEATER
Test No./Type 1/SASS

$$K = \frac{782.687\ (Cp)^2\ (1-B_{wo})^2\ P_s\ M_d}{K_o^2\ M_s\ P_m}$$

where: K = Contant of fixed and assumed parameters (dimensionless)

Pitot coefficient (dimensionless)	C_p	0.84
Water vapor in the gas stream (proportion by volume)	B_{wo}	12% Assumed
Absolute stack gas pressure (in. Hg) STATIC = -0.31	P_s	29.397
Molecular weight, stack gas dry (lb/lb-mole)	M_d	30.07 ASSUMED
Orifice coefficient (dimensionless)	K_o	3.7601
Molecular weight, stack gas wet (lb/lb-mole) $M_d(1-B_{wo}) + 18(B_{wo})$	M_s	28.62 Assumed
Abolute meter pressure (in. Hg)	P_m	29.58
$\frac{782.687\ (0.84)^2\ (1-0.12)^2\ (29.397)\ (30.07)}{(3.760)^2\ (28.62)\ (29.58)}$	K	29.52

FIELD DATA

Page 1 of 2

Plant Tosco, Bakersfield
Date 6-18-81
Sample Location Crude Heater
Sample Type SASS
Run Number 1
Operator J. Holm
Ambient Temperature 95°
Barometric Pressure 29.42
Static Pressure, (H_2O) -0.31
Filter Number(s) 211-003

Leak Check: Initial at 21 " Hg., .021 CFM
Final at ___ " Hg, ___ CFM
Pitot Leak Check: N/A

Impinger Volumes

Initial	Final	Net Gain
500	1580	1080
500	1095	915
500	820	

Silica Gel

750	873.7	
750	868.5 +84.2	326.4

SASS Condensate 778 (ph = 4.0)
Total Volume 5099.4

Probe Length and Type 5 ft / Pyrex
Nozzel Size & I.D. 1.22
Pitot Coefficient & I.D. ___
Assumed Moisture 12%
Molecular Weight, Dry, (M_d) 30.07
Meter Box Number 082
Meter Coefficient 3.7602
α Factor 1.0112
K = 29.52
$K(Nd)^4$ = ___ x (___)^4 = ___
$\Delta H = K(M_d)^4 \left(\frac{Tm}{Ts}\right)$ (P)

Traverse Point Number	Sampling Time, min	Clock Time (24-hr) Clock	Gas Meter Reading (V_m), ft 3	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), in. H_2O Desired	Orifice Pressure Differential (ΔH), in. H_2O Actual	Temperature °F 2/ Stack	Temperature °F Probe	Temperature °F Impinger	Temperature °F Organic Module	Temperature °F Oven	Temperature °F Gas Meter In	Temperature °F Gas Meter Out	Pump Vacuum in. Hg	Avg. $\sqrt{\Delta P}$
	0	1635	Init. 567.354												
48"	5	1645	588.050	1/	2.2	2.3	732	695	85	72	290	96	95	11	
37.75" from inner wall to Nozzle.	15	1655	627.420		2.2	2.3	732	699	82	70	290	99	98	15	
	30	1710	687.9		2.2	2.3	735	721	82	62	290	105	100	15	
	45	1725	750.0		2.2	2.4	740	718	83	63	292	107	101	15	
	60	1740	812.6		2.2	2.4	740	713	83	64	295	105	101	15	
	75	1755	874.5		2.2	2.4	730	715	85	59	290	105	100	15	
	90	1814	932.9		2.2	2.4	720	705	86	59	289	102	100	16	
	105	1829	999.95		2.2	2.5	745	712	86	58	292	107	102	16	
	120	1844	1063.05		2.2	2.5	735	709	86	60	294	106	101	16	

← Power OUT 1636 ON at 1642

82.5 min into test · DRAIN CONDENSATE

7602/5/81/Rev 1

Comments: Pitot tube Does not work! M-5 Velocity Profile at SASS location to be USED.
1/ average ΔP = .08" H_2O (calculated from M-5 preliminary velocity traverse data)
2/ stack temps from M-5 data at near points

Page 2 of 3

Traverse Point Number	Sampling Time, min / Clock Time (24-hr) Clock	Gas Meter Reading (V_m), ft 3	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), in. H_2O		Temperature °F							Pump Vacuum in. Hg	Avg. $\sqrt{\Delta P}$
		Init.		Desired	Actual	2/ Stack	Probe	Impinger	Organic Module	Oven	Gas Meter In	Gas Meter Out		
	135 1859	1115.404		2.2	2.5	745	704	88	64	290	107	101	16	*
	150 1921	1183.2		2.2	2.5	746	704	89	64	281	107	102	17	
	165 1936	1245.25		2.2	2.5	741	709	89	63	290	109	104	17	
	180 1951	1310.6		2.2	2.5	740	706	84	68	294	107	104	17	
	195 2006	1375.4		2.2	2.5	740	707	88	62	296	106	102	17½	
	210 2021	1437.8		2.2	2.5	740	708	86	62	296	106	101	17½	
	225 2036	1501.7		2.2	2.5	790	708	86	62	295	104	100	17½	
	240 2051	MISSED POINT		LOWERING		EQUIPMENT			FROM	M-5			18	
	245 2056	1586.4		2.2	2.5	740	709	86	66	299	108	102	18	
	255 2106	1628.660												
	255 MIN	1061.306	√	2.44										
						21				102.7				

Run No. 1 – SASS

Date 18 JUNE 81

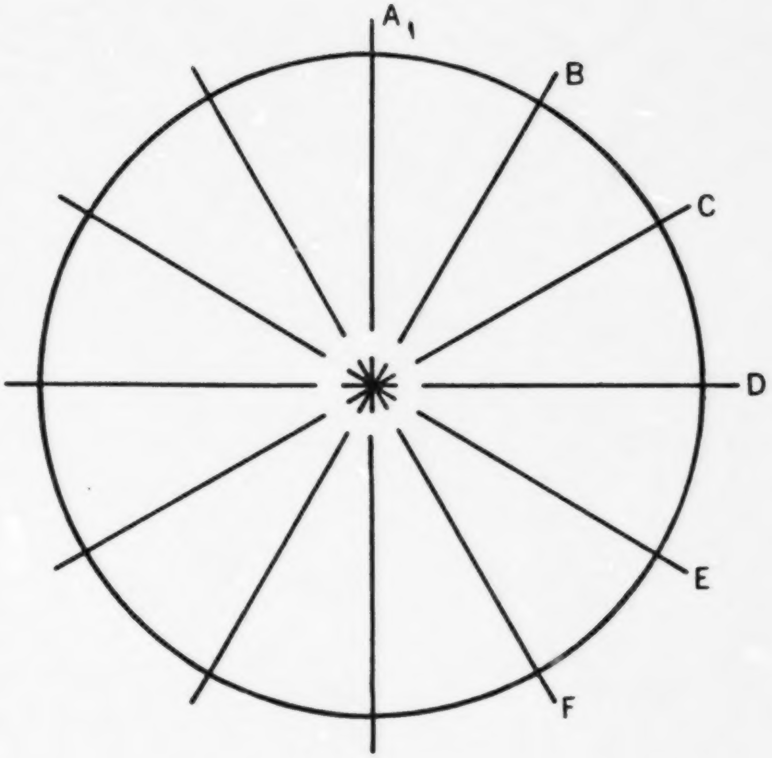
Sampling Location CRUDE HTR

Comments: *135 MIN. into test changed SiO_2
drained condensate

LEAK CHECK DID NOT include probe. It was discovered during the initial leak check for test 2 that the probe had a >1 cfm leak at the inlet to the probe at the BULKHEAD that seals the glass probe to the nozzle.

Reproduced from best available copy.

NOZZLE MEASUREMENT



DIAMETER
DIMENSION
A 1,213
B 1,224
C 1,219
D 1,224
E 1,228
F 1,235

AVG. 1,224 1 7/32
NOZZLE SERIAL

DATE 11/13/80

RECORDED BY

ISOKINECTIC SAMPLING WORKSHEET

Plant TOSCO
Peformed by J. HOLM
Date 19 JUNE 81
Sample Location CRUDE HTR
Test No./Type 2/SASS

$$K = \frac{782.687\ (Cp)^2\ (1-B_{wo})^2\ P_s\ M_d}{K_o^2\ M_s\ P_m}$$

where: K = Contant of fixed and assumed parameters (dimensionless)

$P_b = 29.40$ @ 830 AM

Pitot coefficient (dimensionless)	C_p	0.84
Water vapor in the gas stream (proportion by volume)	B_{wo}	13.5 % ASSUMED
Absolute stack gas pressure (in. Hg) $29.40 - 0.31/13.6$	P_s	29.377
Molecular weight, stack gas dry (lb/lb-mole)	M_d	30.07 assumed.
Orifice coefficient (dimensionless)	K_o	3.7601
Molecular weight, stack gas wet (lb/lb-mole) $M_d(1-B_{wo}) + 18(B_{wo})$ $26.01 + 2.43$	M_s	28.44 assumed
Abolute meter pressure (in. Hg) $29.40 + 2.0/13.6$	P_m	29.55
$\frac{782.687\ (\overset{0.7056}{0.84})^2\ (1-\overset{.7482}{0.135})^2\ (29.38)\ (30.07)}{(\underset{14.138}{3.7601})^2\ (28.44)\ (29.55)}$	K	30.724

Reproduced from best available copy.

FIELD DATA

Page 1 of 2

Plant TOSCO, BAKERSFIELD, CA
Date 6-19-81
Sample Location CRUDE HEATER
Sample Type SASS
Run Number 2
Operator J. HOLM
Ambient Temperature 104°F
Barometric Pressure 29.40 @ 0900
Static Pressure, (H_2O) -0.31
Filter Number(s) MU-211-007

Impinger Volumes

Initial	Final	Net Gain
500	1040	540
500	760	
500	525	285

Silica Gel

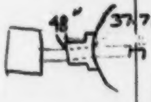
750g	1017.2	267.2
750g	831.4	81.4
750g	822.2	72.2

SASS Condensate 1925 @ pH = 2.5
Total Volume 3170.8

Probe Length and Type 5' PYREX
Nozzel Size & I.D. 1.224 NO I.D.
Pitot Coefficient & I.D. 0.81
Assumed Moisture 13%
Molecular Weight, Dry, (M_d) 30.07
Meter Box Number 082
Meter Coefficient 3.7408 (K_o)
α Factor 1.0112
K = 30.724
$K(Nd)^4$ = ___ x (___)^4 = ___
$\Delta H = K(N_d)^4 \left(\frac{Tm}{TS}\right)$ (P)

Leak Check: Initial at 26 " Hg, 0.068 CFM @ ambient
Final at 26 " Hg, 0.048 CFM @ 280°F
Pitot Leak Check: ______

Probe Location



Traverse Point Number	Sampling Time, min	Clock Time (24-hr) Clock	Gas Meter Reading (V_m), ft³	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), in. H_2O		Temperature °F							Pump Vacuum in. Hg	Avg. $\sqrt{\Delta P}$
					Desired	Actual	Stack	Probe	Impinger	Organic Module	Oven	Gas Meter In	Gas Meter Out		
	0	1130	Init. 640.716												
48"	5	1135	664.050		2.2	2.6		580	90	61	253	108	103	16	
	15	1145	706.8		2.2	2.6		671	91	54	260	117	108	16	
	30	1200	768.44		2.2	2.6		678	91	60	290	123	114	16	
	45	1215	831.02		2.2	2.6		676	87	60	290	118	112	16	
	60	1230	894.18		2.2	2.6		677	88	59	296	120	110	16½	*
1/ 2/	75	1250	957.119		2.2	2.6		668	89	61	287	113	112	16½	*
	90	1308	1020.85		2.2	2.6		675	92	59	287	117	112	16½	
	105	1323	1084.200		2.2	2.6		680	92	61	290	110	105	16½	*
	120	1351	1147.75		2.2	2.6		679	94	60	275	109	104	17	

INITIAL LEAK CHECK TO FILTER FRONT = 0.046 cfm @ 24" Hg ; Entire train (inc. PROBE) = 0.068 cfm @ 26" Hg

7602/5/81/Rev 1

TEST 1, PROBE WAS 37.75" INTO DUCT from inner wall to NOZZLE.

Comments: TEST 2, SAME POSITION

65 min: NOTICED A FEW XAD2 BEADS IN 1ST IMP. Solution

1/ * 70 min into test: DRAINED condensate, Silica Gel O.K NOTE: XAD2 PRESENT (slight amount)

2/ * 75 MIN DRAINED PART of 1ST IMP. INTO NEXT COND. SAMPLE BOTTLE DUE TO EXCESSIVE FOAMING

105 min into TEST: DRAINED COND. CHANGED SO_2

Page 2 of 2

Traverse Point Number	Sampling Time, min	Clock Time (24-hr) Clock	Gas Meter Reading (V_m), ft 3	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), in. H_2O		Temperature °F							Pump Vacuum in. Hg	Avg. $\sqrt{\Delta P}$
			Init.		Desired	Actual	Stack	Probe	Impinger	Organic Module	Oven	Gas Meter In	Gas Meter Out		
48"	135	1406	1210.9		2.2	2.6		673	94	61	289	119	106	17	
[3]	150	1421	1274.253		2.2	2.6		675	93	60	285	111	105	17	
	165	1436	1342.15		2.2	2.6		674	93	60	284	112	106	17	
[4]	180	1451	1402.697		2.2	2.6		675	93	60	284	111	106	17 1/2	
	195	1520	1466.50		2.2	2.6		673	92	59	283	111	105	17 1/2	
	210	1535	1530.40		2.2	2.6		673	93	58	290	112	106	17 1/2	
	225	1550	1594.30		2.2	2.6		672	95	59	290	112	106	17 1/2	
	255		1722.075												
			1081.359		2.2	2.6	696.6 [5]					110.7			.309 [5]

Run No. 2/SASS

Date 6-19-81

Sampling Location ~~CRUDE HEATER~~

[3] *AT 150 MIN. INTO TEST COND. DRAINED. SiO_2 OK

[4] AT 180 MIN.: CHANGED SilicaGEL.

Comments:

[5] From 2/MS Test Data

SECTION 5

ANALYTICAL RESULTS

5.1 Ultimate Analysis of Fuel Oil

5.2 Composition of Refinery Gas

5.3 SASS Particulate Emissions

5.4 EPA Method 5 Particulate Emissions

5.5 Sulfur Oxides Emissions by Turbidometric Analysis

5.6 Trace Element Analyses

5.7 Total Chromatographable Organics (TCO), Gravimetric Organics (GRAV), Infrared (IR) Spectra, Gas Chromatography/Mass Spectrometry (GC/MS) and Low Resolution Mass Spectrometry (LRMS) of Total Sample Extracts

5.8 C_1-C_6 Chromatograms

5.9 Radiometric Analytical Results

5.10 Bioassays

5.1 ULTIMATE ANALYSIS OF FUEL OIL

Prelim. No. 7520
Lab. No. 81ml35

RECEIVED NOV 17 1981

Subcontract PG591862
Release #3

ORIGINAL

November 16,1981
Page 2 of 2

	Tosco 1 #1, Code 813781 1st Test	 2nd Test	 3rd Test	Tosco 2 #2, Code 813782 1st Test	 2nd Test	 3rd Test
Carbon (C),% --------	87.37	--	--	86.66	--	--
Hydrogen (H),% ------	10.47	--	--	10.98	--	--
Oxygen (O), by difference,% ----	0.31	--	--	0.55	--	--
Nitrogen (N),% ------	.71	.88	.90	.74	.90	.92
Sulfur (S),% --------	.92	.94	.96	.93	.90	.88
Heating Value: BUT per Pound ------	18,720	--	--	18,760	--	--
Gravity, API° @ 70°F	12.3	--	--	12.3	--	--
@ 60°F	11.8	--	--	11.8	--	--

Curtis & Tompkins Ltd.

5.2 COMPOSITION OF REFINERY GAS

TOSCO CORPORATION
BAKERSFIELD REFINERY
GAS ANALYSIS REPORT

LABORATORY Gas Lab
OPERATOR J. McMahon
DATE June 18, 1981

UNIT Crude	Fuel Gas To 11H13					
SAMPLE DATE	6-18-81					
SAMPLE TIME	7 15 PM					
PERCENT	Gas Vol.					
HYDROGEN 13	8.7					
NITROGEN 9	1.1					
OXYGEN						
CARBON MONOXIDE 17	0.4					
CARBON DIOXIDE 21						
HYDROGEN SULFIDE 25						
METHANE 29	22.7					
ETHANE 33	16.7					
ETHYLENE 37	3.8					
PROPANE 41	29.2					
PROPYLENE 45	3.3					
ISOBUTANE 49	11.1					
NORMAL BUTANE 53	1.7					
TOTAL BUTENES 57	0.5					
1, 3-BUTADIENE 61						
ISOPENTANE 65	0.2					
NORMAL PENTANE 69	0.1					
TOTAL PENTENES 73						
TOTAL C_6 PLUS 77	0.5					
BTU/Ft^3	1892					
Specific Gravity	1.1381					

DIST GDD (2) LDW
JAK P+I
RWT KVB

REMARKS

PREPARED BY James D. McMahon
SUBMITTED BY A.R. Wyman

81 089 (9 80)

TOSCO CORPORATION
BAKERSFIELD REFINERY
GAS ANALYSIS REPORT

LABORATORY: Gas Lab
OPERATOR: Jim McMahon
DATE: June 22, 1981

UNIT: Crude	Fuel Gas To 11H13					
SAMPLE DATE	6/19/81					
SAMPLE TIME	3^{30} PM					
PERCENT	Gas Vol.					
HYDROGEN 13	9.3					
NITROGEN 9	0.8					
OXYGEN						
CARBON MONOXIDE 17	0.5					
CARBON DIOXIDE 21						
HYDROGEN SULFIDE 25	0					
METHANE 29	24.5					
ETHANE 33	16.5					
ETHYLENE 37	4.0					
PROPANE 41	28.5					
PROPYLENE 45	3.6					
ISOBUTANE 49	9.5					
NORMAL BUTANE 53	1.3					
TOTAL BUTENES 57	0.7					
1, 3-BUTADIENE 61						
ISOPENTANE 65	0.2					
NORMAL PENTANE 69	0.1					
TOTAL PENTENES 73						
TOTAL C_6 PLUS 77	0.5					
BTU/ft^3	1842.6					
Specific Gravity	1.1041					

DIST: GDD(2) LDW JAK P&I RWT KVB
REMARKS:
PREPARED BY: James A. McMahon
SUBMITTED BY:

81 089 (9-80)

5.3 SASS PARTICULATE EMISSIONS

ISOKINETIC PERFORMANCE WORKSHEET & PARTICULATE CALCULATIONS

Plant TOSCO, BAKERSFIELD, CA   Performed by DaRos

Date 6-18-81

Sample Location CRUDE HEATER

Test No./Type 1 /SASS

Barometric Pressure (in. Hg)	P_b	29.42
Meter volume (std), $17.64 \left(\frac{V_m}{\alpha}\right)\left(\frac{P_b + \frac{\Delta H}{13.6}}{T_m + 460}\right)$ $17.64 \left(\frac{(\overset{1061.306}{\_\_\_\_})}{(1.0112)}\right)\left(\frac{(29.42) + \frac{(2.44)}{13.6}}{(1029) + 460}\right)$	$V_{m\ std}$	973.540
Volume of liquid collected (grams)	Vl_c	3099.4
Volume of liquid at standard condition (scf) $Vl_c \times 0.04707$	$V_{w\ std}$	145.889
Stack gas proportion of water vapor $\frac{V_{w\ std}}{V_{w\ std} + V_{m\ std}}$, $\frac{(145.)889}{(\underset{973.540}{\_\_\_\_}) + (145.)889}$	B_{wo}	0.1303
Molecular weight, stack gas dry (lb/lb-mole) $(\%\ CO_2 \times 0.44) + (\%\ O_2 \times 0.32) + (\%\ N_2 + \%\ CO \times 0.28)$ $(\_\_\_ \times 0.44) + (\_\_\_ \times 0.32) + (\_\_\_ + \_\_\_ \times 0.28)$	M_d	30.112
Molecular weight, stack gas wet (lb/lb-mole) $Md(1-B_{wo}) + 18(B_{wo})$, $(30.112)(1-.0144) + 18(.0144)$	M_s	28.53
Absolute stack pressure (in. Hg) $P_b + \frac{P_{stack}\ (\text{in. } H_2O)}{13.6}$, $(\_\_\_) + \frac{(\_\_\_)}{13.6}$	P_s	29.39

7602/5/81/Rev 1

TOSCO 1/SASS 6-18-81

Temperature stack gas, average (^{o}F)	T_s	714.7 [1]
Stack velocity (fps) $85.49\,(C_p)\,(\sqrt{\Delta P}_{s\ avg})\ \sqrt{\frac{T_s avg + 460}{P_s \quad M_s}}$ $85.49\,(\underline{.84})(\overline{.332})\ \sqrt{\frac{(\underline{714.7}) + 460}{(\underline{29.39})\,(29.94)}}$	$V_{s(avg)}$	28.21
Total sample time (minutes)	θ	255
Nozzle diameter, actual (inches)	N_d	1.22
Percent isokinetic (%) $\frac{17.33\,(T_s + 460)(V_w\ std + V_m\ std)}{\theta \quad V_s \quad P_s \quad N_d^2}$ $\frac{17.33\,(\underline{714.7} + 460)((\underline{145.889}) + \overset{973.540}{(\underline{\quad\quad})})}{(\underline{255})(\underline{27.55})(\underline{29.39})(\underline{1.22})^2}$	%I	74.15
Area of stack (ft^2) $\pi = 3.1416$ $\pi r^2 \div 144, \quad \pi(\underline{\quad})^2 \div 144$	A_s	11.79
Stack gas volume at standard conditions (dscfm) $60\,(1 - B_{wo}) Vs_{avg}\ A_s \left(\frac{528}{T_s\ avg + 460}\right)\left(\frac{Ps}{29.92}\right)$ $60\,(1 - \underline{\quad})(\underline{\quad})(\underline{\quad})\left(\frac{528}{\underline{\quad\quad} + 460}\right)\left(\frac{(\underline{\quad})}{(29.92)}\right)$	Q_s	7662.7
Particulate matter concentration, dry (gr/dscf) $15.432\ \frac{M_p(grams)}{Vm_{std}}, \quad 15.432\ \frac{(\underline{\quad\quad})}{(\underline{\quad\quad\quad})}$	$C_{s(std)}$	
Emission rate of particulate matter (lb/hr) $0.00857\ (Q_s)\ C_{s(std)}, \ 0.00857\ (\underline{\quad\quad\quad})(\underline{\quad\quad\quad})$	E_p	

[1] From M-5 Run No 1

ISOKINETIC PERFORMANCE WORKSHEET & PARTICULATE CALCULATIONS

Plant TOSCO, BAKERSFIELD, CA
Performed by DaRos
Date 6-19-81
Sample Location CRUDE HEATER
Test No./Type 2/SASS

Barometric Pressure (in. Hg)	P_b	29.40
Meter volume (std), $17.64\left(\frac{V_m}{\alpha}\right)\left(\frac{P_b + \frac{\Delta H}{13.6}}{T_m + 460}\right)$ $17.64\left(\frac{(1081.359)}{(1.011)}\right)\left(\frac{(29.40) + \frac{(2.6)}{13.6}}{(110.7) + 460}\right)$	$V_{m\ std}$	978.299
Volume of liquid collected (grams)	Vl_c	3170.8
Volume of liquid at standard condition (scf) $Vl_c \times 0.04707$	$V_{w\ std}$	149.25
Stack gas proportion of water vapor $\frac{V_{w\ std}}{V_{w\ std} + V_{m\ std}}, \frac{(\_\_\_)}{(\_\_\_) + (\_\_\_)}$	B_{wo}	.132
Molecular weight, stack gas dry (lb/lb-mole) $(\%\ CO_2 \times 0.44) + (\%\ O_2 \times 0.32) + (\%\ N_2 + \%\ CO \times 0.28)$ $(\_\_\_ \times 0.44) + (\_\_\_ \times 0.32) + (\_\_\_ + \_\_\_ \times 0.28)$	M_d	1/ 30.00
Molecular weight, stack gas wet (lb/lb-mole) $Md(1-B_{wo}) + 18(B_{wo}), (30.00)(1-.132) + 18(.132)$	M_s	28,42
Absolute stack pressure (in. Hg) $P_b + \frac{P_{stack}\ (\text{in. } H_2O)}{13.6}, (\_\_\_) + \frac{(\_\_\_)}{13.6}$	P_s	1/ 29.38

7602/5/81/Rev 1

TOSCO 2/SASS 6-19-81

Temperature stack gas, average (^{o}F)	T_s	696.6 [1]
Stack velocity (fps) $85.49\ (C_p)\ (\sqrt{\Delta P}_{s\ avg})\ \sqrt{\dfrac{T_s avg + 460}{P_s\quad M_s}}$ $85.49\ (\underline{.84})(\overline{309})\ \sqrt{\dfrac{(\underline{696.6}) + 460}{(\underline{29.38})(\underline{28.42})}}$	$V_{s(avg)}$	26.12
Total sample time (minutes)	θ	255
Nozzle diameter, actual (inches)	N_d	1.224
Percent isokinetic (%) $\dfrac{17.33\ (T_s + 460)(V_w\ std + V_m\ std)}{\theta\quad V_s\quad P_s\quad N_d^2}$ $\dfrac{17.33\ (\underline{696.6} + 460)((\underline{14825}) + (\underline{978.299}))}{(\underline{255})(\underline{26.12})(\underline{29.38})(\underline{1.22})^2}$	%I	77.59
Area of stack (ft^2) $\pi = 3.1416$ $\pi r^2 \div 144, \quad \pi(\_\_\_)^2 \div 144$	A_s	
Stack gas volume at standard conditions (dscfm) $60\ (1 - B_{wo})Vs_{avg}\ A_s \left(\dfrac{528}{T_s\ avg + 460}\right)\left(\dfrac{Ps}{29.92}\right)$ $60\ (1 - \_\_)(\_\_)(\_\_)\left(\dfrac{528}{\_\_\_ + 460}\right)\left(\dfrac{(\_\_)}{(29.92)}\right)$	Q_s	
Particulate matter concentration, dry (gr/dscf) $15.432\ \dfrac{M_p(grams)}{Vm_{std}}, \quad 15.432\ \dfrac{(\_\_\_)}{(\_\_\_)}$	$C_{s(std)}$	
Emission rate of particulate matter (lb/hr) $0.00857\ (Q_s)\ C_{s(std)},\ 0.00857\ (\_\_\_)(\_\_\_)$	E_p	

[1] Data from 2/M-5 Test

ACUREX Corporation
ANALYSIS LABORATORIES

DATA REPORTING FORM

CUSTOMER CMEA
DATE
CUSTOMER CONTRACT NO. 307605.92
ACUREX CONTRACT NO. A81-07-011
RESULTS REPORT TO L. Waterland
TELEPHONE
ADDRESS
TOSCO

SAMPLE ID (CUSTOMER)	I-Probe	II Probe	I-Filter	II-Filter	Filter Blk					
SAMPLE ID (LAB)	543	556	545	038	571					
PARAMETER										UNITS
Weight			3.1424	3.2191	2.9151					gram
Initial weight			2.9029	2.9939	2.9151					gram
Ash weight	0.0077	0.0453	0.2395	0.2252	<0.0004					gram

ANALYST
REVIEWER

Form EED-057 4/80

5.4 EPA METHOD 5 PARTICULATE EMISSIONS

ISOKINETIC PERFORMANCE WORKSHEET & PARTICULATE CALCULATIONS

Plant TOSCO, BAKERSFIELD, CA.

Performed by DiaRos

Date 6-18-81

Sample Location CRUDE HEATER

Test No./Type 1/M-5

Barometric Pressure (in. Hg)	P_b	29.42
Meter volume (std), $17.64 \left(\frac{V_m}{\alpha}\right)\left(\frac{P_b + \frac{\Delta H}{13.6}}{T_m + 460}\right)$ $17.64 \left(\frac{\overset{103.984}{(\underline{\quad})}}{(\underline{1.010})}\right)\left(\frac{(\underline{29.42}) + \frac{(\underline{1.16})}{13.6}}{(\underline{111.35}) + 460}\right)$	$V_{m\ std}$	93.787
Volume of liquid collected (grams)	Vl_c	376.2
Volume of liquid at standard condition (scf) $Vl_c \times 0.04707$	$V_{w\ std}$	17.708
Stack gas proportion of water vapor $\frac{V_{w\ std}}{V_{w\ std} + V_{m\ std}}$, $\frac{(\underline{17.708})}{(\underline{17.708}) + (\underline{93.787})}$	B_{wo}	.159
Molecular weight, stack gas dry (lb/lb-mole) $(\%\ CO_2 \times 0.44) + (\%\ O_2 \times 0.32) + (\%\ N_2 + \%\ CO \times 0.28)$ $(\underline{12.2} \times 0.44) + (\underline{4.0} \times 0.32) + (\underline{83.8} + \underline{0} \times 0.28)$	M_d	[1] 30.112
Molecular weight, stack gas wet (lb/lb-mole) $Md(1-B_{wo}) + 18(B_{wo})$, $(\underline{30.112})(1-\underline{.159}) + 18(\underline{.159})$	M_s	28.19
Absolute stack pressure (in. Hg) $P_b + \frac{P_{stack}\ (\text{in. } H_2O)}{13.6}$, $(\underline{29.42}) + \frac{(\underline{-.31})}{13.6}$	P_s	29.39

7602/5/81/Rev 1

[1] Molecular weight from B. DeRossier Field Data (KVB - CM instrument van)

TOSCO 1/M-5 6-18-81

Temperature stack gas, average (^{O}F)	T_s	714.7
Stack velocity (fps) $85.49\,(C_p)\,(\sqrt{\Delta P}_{s\ avg})\sqrt{\frac{T_s avg + 460}{P_s\quad M_s}}$ $85.49\,(\underline{.84})(\ .332)\sqrt{\frac{(\underline{714.7}) + 460}{(\underline{29.39})(\underline{28.19})}}$	$V_{s(avg)}$	28.39
Total sample time (minutes)	θ	180
Nozzle diameter, actual (inches)	N_d	.382
Percent isokinetic (%) $\frac{17.33\,(T_s + 460)(V_w\ std + V_m\ std)}{\theta \quad V_s \quad P_s \quad N_d^2}$ $\frac{17.33\,(\underline{714.7} + 460)((\underline{17.708}) + (\overset{93.787}{\underline{\quad}}))}{(\underline{180})(\underline{28.39})(\underline{29.39})(\underline{.382})^2}$	%I	103.57
Area of stack (ft^2) $\pi = 3.1416$ $\pi r^2 \div 144$, $\pi(\underline{\quad})^2 \div 144$	A_s	11.79
Stack gas volume at standard conditions (dscfm) $60\,(1 - B_{wo})Vs_{avg}\,A_s\left(\frac{528}{T_s\ avg + 460}\right)\left(\frac{Ps}{29.92}\right)$ $60\,(1 - \underline{\quad})(\underline{\quad})(\underline{\quad})\left(\frac{528}{\underline{\quad} + 460}\right)\left(\frac{(\underline{\quad})}{(29.92)}\right)$	Q_s	7458
Particulate matter concentration, dry (gr/dscf) $15.432\,\frac{M_p(grams)}{Vm_{std}}$, $15.432\,\frac{(\underline{\quad\quad})}{(\underline{\quad\quad})}$	$C_{s(std)}$	
Emission rate of particulate matter (lb/hr) $0.00857\,(Q_s)\,C_{s(std)}$, $0.00857\,(\underline{\quad\quad})(\underline{\quad\quad})$	E_p	

7602/5/81/Rev 1

ISOKINETIC PERFORMANCE WORKSHEET & PARTICULATE CALCULATIONS

Plant TOSCO, BAKERSFIELD, CA

Performed by DuRos

Date 6-19-81

Sample Location CRUDE HEATER

Test No./Type 2/M-5

Barometric Pressure (in. Hg)	P_b	29.40
Meter volume (std), $17.64 \left(\frac{V_m}{\alpha}\right)\left(\frac{P_b + \frac{\Delta H}{13.6}}{T_m + 460}\right)$ $17.64 \left(\frac{(97.64)}{(1.010)}\right)\left(\frac{(29.40) + \frac{(.97)}{13.6}}{(112.2) + 460}\right)$	$V_{m\ std}$	87.853
Volume of liquid collected (grams)	Vl_c	367.7
Volume of liquid at standard condition (scf) $Vl_c \times 0.04707$	$V_{w\ std}$	17.308
Stack gas proportion of water vapor $\frac{V_{w\ std}}{V_{w\ std} + V_{m\ std}}$, $\frac{(17.308)}{(12.308) + (87.853)}$	B_{wo}	.1646
Molecular weight, stack gas dry (lb/lb-mole) (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28) (11.7 x 0.44) + (3.3 x 0.32) + (85 + ___ x 0.28)	M_d	1/ 30.00
Molecular weight, stack gas wet (lb/lb-mole) $Md(1-B_{wo}) + 18(B_{wo})$, (30.00)(1-.1646) + 18(.1646)	M_s	28.03
Absolute stack pressure (in. Hg) $P_b + \frac{P_{stack}\ (\text{in. } H_2O)}{13.6}$, $(29.40) + \frac{(-.31)}{13.6}$	P_s	29.38

7602/5/81/Rev 1

1/ From B. DeRosier field data KVB - CM van

TOSCO 2/M-5 6-19-81

Temperature stack gas, average (^oF)	T_s	696.6
Stack velocity (fps) $85.49\,(C_p)\,(\sqrt{\Delta P_{s\ avg}})\,\sqrt{\dfrac{T_s avg + 460}{P_s\quad M_s}}$ $85.49\,(\underline{.84})(\sqrt{.309})\,\sqrt{\dfrac{(\underline{696.6}) + 460}{(\underline{29.38})(\underline{28.03})}}$	$V_{s(avg)}$	26.3
Total sample time (minutes)	θ	180
Nozzle diameter, actual (inches) (SN907)	N_d	.382
Percent isokinetic (%) $\dfrac{17.33\,(T_s + 460)(V_w\ std + V_m\ std)}{\theta \quad V_s \quad P_s \quad N_d^2}$ $\overline{20295.33}$ $\dfrac{17.33\,(\underline{696.6} + 460)((\underline{17.308}) + (\overset{87.833}{\underline{\quad}}))}{(\underline{180})(\underline{26.3})(\underline{29.38})(\underline{.382})^2}$	%I	103.84
Area of stack (ft^2) $\pi = 3.1416$ $\pi r^2 \div 144$, $\pi(\underline{\quad})^2 \div 144$	A_s	11.79
Stack gas volume at standard conditions (dscfm) $60\,(1 - B_{wo})Vs_{avg}\,A_s \left(\dfrac{528}{T_s\ avg + 460}\right)\left(\dfrac{Ps}{29.92}\right)$ $60\,(1 - \underline{\quad})(\underline{\quad})(\underline{\quad})\left(\dfrac{528}{\underline{\quad} + 460}\right)\left(\dfrac{(\underline{\quad})}{(29.92)}\right)$	Q_s	967.2
Particulate matter concentration, dry (gr/dscf) $15.432\,\dfrac{M_p(grams)}{Vm_{std}}$, $15.432\,\dfrac{(\underline{\quad})}{(\underline{\quad})}$	$C_{s(std)}$	
Emission rate of particulate matter (lb/hr) $0.00857\,(Q_s)\,C_{s(std)}$, $0.00857\,(\underline{\quad})(\underline{\quad})$	E_p	

7602.92

E.C. DaRos

CMEA: TOSCO

BAKERSFIELD, CA

TEST I.D.	Vm(STD)	FRONT HALF		BACK HALF					
		PROBE & NOZZEL CATCH (Mg) 1/	M-5 FILTER CATCH (Mg) 1/	IMPINGER RINSE (acetone) (Mg) 1/	IMPINGER CONTENTS				
					AQUEOUS PHASE (Mg) 1/	ORGANIC PHASE (Mg) 1/			
M-5 TEST 1	93.787	33.81	48.81	2.02	2.08	20.84			
M-5 TEST 2	87.833	2.88	46.92	7.54	.30	.21			

1/ Blank corrected value.

ACUREX
ANALYTICAL REPORT

Sample of: Tosco

Sample Date: June 16 and 19, 1981

Requested By: Bruce Daros

I.D. Number: 7602.92/CMEA

Analytical Method: EPA Method 5 Protocol- Ether/Chloroform Extractions of Impinger Liquids

Date of Analysis: September 3, 1981

Lab I.D. Number	Component	Analytical Result	Unit
813795- Test 1	175 mls		
- Organic Fraction Back Half		2.02	Net Gain milligrams
813579- Test 2	140 mls		
- Organic Fraction Back Half		7.54	

Analysis By J. Sayer / L. Whitmer

Date September 15, 1981

Form EED-082 5/81

ACUREX
ANALYTICAL REPORT

Sample of: Tosco

Sample Date: June 16 and 19, 1981

Requested By: Bruce Daros

I.D. Number: 7602.92/CMEA

Analytical Method: EPA Method 5 Protocol - Ether/Chloroform Extraction of Impinger Liquids

Date of Analysis: Sept. 3, 1981

Lab I.D. Number	Component	Analytical Result	Unit
813549 - Test 1	484 mls		
- Aqueous Phase		3.57 -1.49 = 2.08	
- Organic Phase		21.84 -.87 = 20.84	Net Gain milligrams
813578 - Test 2	485 mls		
- Aqueous Phase		1.79 -1.49 = .30	
- Organic Phase		1.08 -.87 = .21	
813574 - Water Blank	218 mls		
- Aqueous Phase		0.67 .00307 mg/ml	
- Organic Phase		0.87	

Analysis By: J. Sayer / L. Whitman

Date: September 15, 1981

ACUR EX
ANALYTICAL REPORT

Sample of: Tosco

Sample Date: June 16 and 19, 1981

Requested By: Bruce Daros

I.D. Number: 7602.92/CMEA

Analytical Method: Gravimetric Analysis of Filters

Date of Analysis: July 31, 1981

Lab I.D. Number	Component	Analytical Result	Unit
813548 - Test #1	96-34	48.81	Net Gain milligrams
813577 - Test #2	96-35	46.92	

Analysis By J. Sayer / L. Whitman

Date 9/15/81

ACUREX
ANALYTICAL REPORT

Sample of: Tosco

Sample Date: June 16 and 19, 1981

Requested By: Bruce Daros

I.D. Number: 7602.92/CMEA

Analytical Method: Gravimetric Analysis of Acetone Probe Wash

Date of Analysis: September 1 and 2, 1981

Lab I.D. Number	Component	Analytical Result	Unit
813546 - Test 1	45 mls	34.08 -.27 = 33.81	Net Gain milligrams
813576 - Test 2	110 mls	3.54 -.66 = 2.88	
813547 - Acetone Blank	100. -	0.60 .006 mg/ml	

Analysis By J. Sayer / L. Whitmer

Date September 16, 1981

Form EED-082 5/81

5.5 SULFUR OXIDES EMISSIONS BY TURBIDOMETRIC ANALYSIS

CONTROLLED CONDENSATION SYSTEM (CCS)
LABORATORY DATA SHEET

Plant TOSCO, BAKERSFIELD, CA
Date 6-8-81
Sample Location CRUDE HEATER
Run No. 1-CCS

Analyst B.C. DaRos
Date Lab Analysis Completed 10-21-81

Titration Data

Method BARIUM/ THORIN Titrant $BaCl_2$ 80% IPA Normality .0166 Indicator THORIN

Sample Description	Probe, Nozzle and Filter Rinse	G/R Coil Rinse	Impinger Contents and Rinse	H_2O Blank	3% H_2O_2 Blank
Sample No.	813552	813553	813575	813793	813551
Vol. of Sample	80.0	66.0	224.0	UNITY	UNITY
Vol. of Aliquot	10.0	10.0	10.0	10.0	10.0
Vol. of Titrant Used	1/	.90 .95 .95	10.85 10.65 10.70	.05 .05 —	.05 .05 —
Average Vol. of Titrant Used	—	.93	10.73	.05	.05

Calculations

Vol. of Gas Sampled (V_M) 19.26 ft^3, Avg. Meter Temp (T_M) 116.3 °F,
Meter Pressure (P_M) 29.43 "Hg, Meter α Factor .998 dimensionless

$\frac{(.95-.05).0166N}{10.0} = .0015N$, $.0015N \times 66.0 = .099\ mEg\ SO_4/Sample$

$\frac{96 \times .099}{2} = 4.733\ Mg\ SO_4$

$$PPM\ SO_4 = \frac{48.15\ (\overset{4.733}{\_\_\_},\ MgSO_4)(116.3,\ T_M+460)}{96\ (19.26,\ V_M)(29.43,\ P_M)}\ (.998, \alpha)$$

ppm SO_4 = 2.41

$\frac{(10.73-.05).0166N}{10.0} = .0177N$, $.0177N \times 224.0 = 3.97\ mEg\ SO_4/Sample$

$\frac{3.97 \times 96}{2} = 190.58\ Mg\ SO_4$

$190.58 \times \left(\frac{64}{96}\right) = 127.04\ Mg\ SO_2$

$$PPM\ SO_2 = \frac{48.15\ (\overset{127.04}{\_\_\_},\ MgSO_2)(116.3,\ T_M+460)}{64\ (19.26,\ V_M)(29.43,\ P_M)}\ (.998, \alpha)$$

ppm SO_2 = 96.98

1/ COLOR CHANGE UPON ADDITION OF INDICATOR

Reproduced from best available copy.

ISOKINETIC PERFORMANCE WORKSHEET & PARTICULATE CALCULATIONS

Plant TOSCO, BAKERSFIELD, CA   Performed by DuRos
Date 6-18-81
Sample Location CRUDE HEATER
Test No./Type 1/CCS

Barometric Pressure (in. Hg)	P_b	29.42
Meter volume (std), $17.64 \left(\frac{V_m}{\alpha}\right)\left(\frac{P_b + \frac{\Delta H}{13.6}}{T_m + 460}\right)$ $17.64 \left(\frac{(19.26)}{(998)}\right)\left(\frac{(29.42) + \frac{(.1)}{13.6}}{(116.3) + 460}\right)$	$V_{m\ std}$	17.38
Volume of liquid collected (grams)	Vl_c	
Volume of liquid at standard condition (scf) $Vl_c \times 0.04707$	$V_{w\ std}$	
Stack gas proportion of water vapor $\frac{V_{w\ std}}{V_{w\ std} + V_{m\ std}}, \frac{(\_\_\_)}{(\_\_\_) + (\_\_\_)}$	B_{wo}	
Molecular weight, stack gas dry (lb/lb-mole) $(\%\ CO_2 \times 0.44) + (\%\ O_2 \times 0.32) + (\%\ N_2 + \%\ CO \times 0.28)$ $(\_\_\_ \times 0.44) + (\_\_\_ \times 0.32) + (\_\_\_ + \_\_\_ \times 0.28)$	M_d	
Molecular weight, stack gas wet (lb/lb-mole) $Md(1-B_{wo}) + 18(B_{wo}), (\_\_\_)(1-\_\_\_) + 18(\_\_\_)$	M_s	
Absolute stack pressure (in. Hg) $P_b + \frac{P_{stack}\ (in.\ H_2O)}{13.6}, (\_\_\_) + \frac{(\_\_\_)}{13.6}$	P_s	

7602/5/81/Rev 1

CONTROLLED CONDENSATION SYSTEM (CCS)
LABORATORY DATA SHEET

Plant TOSCO, BAKERSFIELD, CA
Date 6-19-81
Sample Location CRUDE HEATER
Run No. 2-CCS

Analyst R.C. DaRos
Date Lab Analysis Completed 10-21-81

Titration Data

Method BARIUM/THORIN Titrant $BaCl_2$ 80% IPA Normality .0166 Indicator THORIN

Sample Description	Probe, Nozzle and Filter Rinse	G/R Coil Rinse	Impinger Contents and Rinse	H_2O Blank	3% H_2O_2 Blank
Sample No.	813790	813791	813792	813793	
Vol. of Sample	80.0	68.0	222.0	UNITY	UNITY
Vol. of Aliquot	10.0	10.0	10.0	10.0	10.0
Vol. of Titrant Used	✓	.75 .80 .75	14.25 14.20 14.20	.05 .05 —	.05 .05 —
Average Vol. of Titrant Used	—	.767	14.22	.05	.05

Calculations

Vol. of Gas Sampled (V_M) 21.325 ft³, Avg. Meter Temp (T_M) 115.4 °F,
Meter Pressure (P_M) 29.41 "Hg, Meter α Factor .998 dimensionless

$\frac{(.767-.05)\,.0166N}{10.0} = .0012N$, $.0012N \times 68.0 = .0816$ mEq SO_4/Sample

$\frac{96 \times .0816}{2} = 3.917$ Mg SO_4

$$PPM\ SO_4 = \frac{48.15\ (\overset{3.917}{\_\_\_},\ MgSO_4)(\underline{115.4},\ T_M+460)}{96\ (\underline{21.325},\ V_M)(\underline{29.41},\ P_M)}\ (\underline{.998},\alpha)$$

ppm SO_4 = 1.8

$\frac{(14.22-.05)\,.0166N}{10.0} = .0235N$, $.0235N \times 222.0 = 5.222$ mEq SO_4/Sample

$\frac{5.222 \times 96}{2} = 250.65$

$250.65 \times \left(\frac{64}{96}\right) = 167.10$

$$PPM\ SO_2 = \frac{48.15\ (\overset{167.1}{\_\_\_},\ MgSO_2)(\underline{115.4},\ T_M+460)}{64\ (\underline{21.325},\ V_M)(\underline{29.41},\ P_M)}\ (\underline{.998},\alpha)$$

ppm SO_2 = 114.7

ISOKINETIC PERFORMANCE WORKSHEET & PARTICULATE CALCULATIONS

Plant TOSCO, BAKERS FIELD, CA   Performed by Dm Ros

Date 6-19-81

Sample Location CRUDE HEATER

Test No./Type 2/CCS

Barometric Pressure (in. Hg)	P_b	29.40
Meter volume (std), $17.64\left(\frac{V_m}{\alpha}\right)\left(\frac{P_b+\frac{\Delta H}{13.6}}{T_m+460}\right)$ $17.64\left(\frac{(21.32)}{(.998)}\right)\left(\frac{(29.40)+\frac{(.1)}{13.6}}{(113.4)+460}\right)$	$V_{m\ std}$	19.32
Volume of liquid collected (grams)	Vl_c	
Volume of liquid at standard condition (scf) $Vl_c \times 0.04707$	$V_{w\ std}$	
Stack gas proportion of water vapor $\frac{V_{w\ std}}{V_{w\ std}+V_{m\ std}},\ \frac{(\_\_\_)}{(\_\_\_)+(\_\_\_)}$	B_{wo}	
Molecular weight, stack gas dry (lb/lb-mole) (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28) (___ x 0.44) + (___ x 0.32) + (___ + ___ x 0.28)	M_d	
Molecular weight, stack gas wet (lb/lb-mole) $Md(1-B_{wo})+18(B_{wo})$, (___)(1-___) + 18(___)	M_s	
Absolute stack pressure (in. Hg) $P_b+\frac{P_{stack}\ (\text{in. } H_2O)}{13.6},\ (\_\_\_)+\frac{(\_\_\_)}{13.6}$	P_s	

7602/5/81/Rev 1

5.6 TRACE ELEMENT ANALYSES

Fuel

Filter

Filter Blank

XAD

XAD Blank

Impinger 1

Impinger 1 Blank

Mercury, Antimony, Arsenic

COMMERCIAL TESTING & ENGINEERING CO.
GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434
Reply to INSTRUMENTAL ANALYSIS DIVISION, 14335 WEST 44TH AVENUE, GOLDEN, COLORADO 80401, PHONE 303-278-9521

To: Mr. Roy Belletto
Acurex Corporation
485 Clyde Street
Mountain View, CA 94042

Release No. 7

P. O. No.:

Sample No.: 10-24-3
CTE 781

Teser / Feed

RECEIVED
JAN 04 REC'D
ACUREX

Date: December 29, 1981

Analyst: J. Oldham

IAD No.: 97-H690-116-13

SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS

CONCENTRATION IN PPM WEIGHT

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	≤0.5	Terbium		Ruthenium		Vanadium	2
Thorium	≤0.4	Gadolinium		Molybdenum		Titanium	6
Bismuth		Europium		Niobium		Scandium	<0.1
Lead	0.2	Samarium		Zirconium	0.8	Calcium	30
Thallium		Neodymium		Yttrium	0.2	Potassium	80
Mercury	NR	Praseodymium		Strontium	0.1	Chlorine	2
Gold		Cerium		Rubidium		Sulfur	>320
Platinum	2	Lanthanum		Bromine	0.5	Phosphorus	9
Iridium		Barium	2	Selenium		Silicon	45
Osmium		Cesium		Arsenic		Aluminum	15
Rhenium		Iodine	0.1	Germanium		Magnesium	10
Tungsten		Tellurium		Gallium	0.3	Sodium	≤0.1
Tantalum		Antimony		Zinc	9	Fluorine	≈0.2
Hafnium		Tin		Copper	7	Oxygen	NR
Lutetium		Indium	STD	Nickel	8	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	<0.1	Carbon	NR
Thulium		Silver		Iron	13	Boron	0.1
Erbium		Palladium		Manganese	0.7	Beryllium	
Holmium		Rhodium		Chromium	0.6	Lithium	0.9
Dysprosium						Hydrogen	NR

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.1ppm
MC — Major Component
INT — Interference

Approved: Robert L. Taylor
for M L Jacobs 29 Dec 81.

COMMERCIAL TESTING & ENGINEERING CO.
GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434
Reply to INSTRUMENTAL ANALYSIS DIVISION, 14335 WEST 44TH AVENUE, GOLDEN, COLORADO 80401, PHONE 303-278-9521

To: Mr. Roy Belletto
Acurex Corporation
485 Clyde Street
Mountain View, CA 94042

Date: December 29, 1981

Release No. 7

Analyst: J. Oldham

P. O. No.:

Sample No.: 10-24-5
CTE 782
Tosco 3 Feed

IAD No.: 97-H690-116-13

SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS
CONCENTRATION IN PPM WEIGHT

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	<0.8	Terbium		Ruthenium		Vanadium	0.8
Thorium	<0.9	Gadolinium		Molybdenum		Titanium	10
Bismuth		Europium		Niobium		Scandium	
Lead	0.9	Samarium		Zirconium		Calcium	16
Thallium		Neodymium		Yttrium		Potassium	66
Mercury	NR	Praseodymium		Strontium	0.5	Chlorine	5
Gold		Cerium		Rubidium		Sulfur	33
Platinum	*11	Lanthanum		Bromine		Phosphorus	5
Iridium		Barium	1	Selenium		Silicon	16
Osmium		Cesium		Arsenic		Aluminum	13
Rhenium		Iodine		Germanium		Magnesium	12
Tungsten		Tellurium		Gallium	0.1	Sodium	6
Tantalum		Antimony		Zinc	3	Fluorine	≈0.4
Hafnium		Tin		Copper	6	Oxygen	NR
Lutetium		Indium	STD	Nickel	8	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	≤0.2	Carbon	NR
Thulium		Silver		Iron	26	Boron	1
Erbium		Palladium		Manganese	0.5	Beryllium	
Holmium		Rhodium		Chromium	1	Lithium	2
Dysprosium	-					Hydrogen	NR

* Heterogeneous

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.1ppm
MC — Major Component
INT — Interference

Approved: Robert C. Taylor
for M L Jacobs 29 Dec. '81

COMMERCIAL TESTING & ENGINEERING CO.
GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434
Reply to INSTRUMENTAL ANALYSIS DIVISION, 14335 WEST 44TH AVENUE, GOLDEN, COLORADO 80401, PHONE 303-278-9521

To: Mr. Roy Belletto
Acurex Corporation
485 Clyde Avenue
Mountain View, CA. 94042

Date: October 14, 1981

Analyst: J. Oldham

P. O. No.: Release No. 6 Exhibit A
Subcontract No. SW59159A

Sample No.: A81-07-011-545 SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS

IAD No.: 97-H437-116-13

TOSCO 1 FILTER

CONCENTRATION IN μg/cm^2

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium		Terbium		Ruthenium		Vanadium	0.2
Thorium		Gadolinium		Molybdenum	0.004	Titanium	0.004
Bismuth		Europium		Niobium	<0.0001	Scandium	<0.0001
Lead	0.003	Samarium		Zirconium	0.005	Calcium	MC
Thallium		Neodymium		Yttrium	0.0001	Potassium	>0.4
Mercury	NR	Praseodymium	<0.0001	Strontium	0.001	Chlorine	0.008
Gold		Cerium	0.0002	Rubidium	0.0007	Sulfur	>0.2
Platinum		Lanthanum	0.0003	Bromine	0.003	Phosphorus	0.01
Iridium		Barium	0.009	Selenium	<0.0001	Silicon	MC
Osmium		Cesium		Arsenic	NR	Aluminum	>0.03
Rhenium		Iodine	0.0002	Germanium	<0.0001	Magnesium	MC
Tungsten		Tellurium	0.0001	Gallium	0.001	Sodium	>0.08
Tantalum		Antimony	NR	Zinc	0.05	Fluorine	≈0.1
Hafnium		Tin	<0.0001	Copper	0.004	Oxygen	NR
Lutetium		Indium	STD	Nickel	MC	Nitrogen	NR
Ytterbium		Cadmium	0.0002	Cobalt	0.01	Carbon	NR
Thulium		Silver	0.001	Iron	0.2	Boron	>0.6
Erbium		Palladium		Manganese	0.002	Beryllium	<0.001
Holmium		Rhodium		Chromium	0.004	Lithium	0.01
Dysprosium						Hydrogen	NR

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.0001 μg/cm^2
MC — Major Component >1 μg/cm^2
INT — Interference

Approved: M J Brooks

COMMERCIAL TESTING & ENGINEERING CO.
GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434
Reply to INSTRUMENTAL ANALYSIS DIVISION, 14335 WEST 44TH AVENUE, GOLDEN, COLORADO 80401, PHONE 303-278-9521

To: Mr. Roy Belletto
Acurex Corporation
485 Clyde Avenue
Mountian View, CA 94042

Date October 14, 1981

Release No. 6 Exhibit A
P. O. No. Subcontract No. SW59159A

Analyst J. Oldham

Sample No.: A81-07-011-038

SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS

IAD No.: 97-H437-116-13

TOSCO 2 FILTER

CONCENTRATION IN $\mu g/cm^2$

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	0.0003	Terbium		Ruthenium		Vanadium	0.2
Thorium	0.0003	Gadolinium		Molybdenum	0.009	Titanium	0.02
Bismuth		Europium		Niobium	<0.0001	Scandium	<0.0001
Lead	0.006	Samarium		Zirconium	0.002	Calcium	MC
Thallium		Neodymium		Yttrium	0.0003	Potassium	>0.4
Mercury	NR	Praseodymium	<0.0001	Strontium	0.002	Chlorine	0.02
Gold		Cerium	0.0005	Rubidium	0.0003	Sulfur	>0.2
Platinum		Lanthanum	0.0004	Bromine	0.002	Phosphorus	0.02
Iridium		Barium	0.02	Selenium	0.0004	Silicon	MC
Osmium		Cesium		Arsenic	NR	Aluminum	>0.03
Rhenium		Iodine	0.0001	Germanium	0.0002	Magnesium	MC
Tungsten		Tellurium	<0.0001	Gallium	0.001	Sodium	>0.08
Tantalum		Antimony	NR	Zinc	0.05	Fluorine	≈0.1
Hafnium		Tin	0.0001	Copper	0.01	Oxygen	NR
Lutetium		Indium	STD	Nickel	0.9	Nitrogen	NR
Ytterbium		Cadmium	0.0002	Cobalt	0.02	Carbon	NR
Thulium		Silver	0.01	Iron	0.3	Boron	0.1
Erbium		Palladium		Manganese	0.01	Beryllium	<0.0001
Holmium		Rhodium		Chromium	0.04	Lithium	0.002
Dysprosium						Hydrogen	NR

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.0001 $\mu g/cm^2$
MC — Major Component > 1 $\mu g/cm^2$
INT — Interference

Approved: MJ Jacobs

COMMERCIAL TESTING & ENGINEERING CO.
GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434
Reply to INSTRUMENTAL ANALYSIS DIVISION, 14335 WEST 44TH AVENUE, GOLDEN, COLORADO 80401, PHONE: 303-278-9521

To: Mr. Roy Belletto
Acurex Corporation
485 Clyde Avenue
Mountain View, CA 94042

Date October 14, 1981

Release No. 6 Exhibit A
P. O. No.: Subcontract No. SW59159A

Analyst: J. Oldham

Sample No A81-07-011-571 SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS

IAD No.: 97-H437-116-13

TOSCO FILTER BLANK

CONCENTRATION IN $\mu g/cm^2$

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium		Terbium		Ruthenium		Vanadium	0.0003
Thorium		Gadolinium		Molybdenum	0.0002	Titanium	0.1
Bismuth		Europium		Niobium	0.0001	Scandium	<0.0001
Lead	0.0007	Samarium		Zirconium	0.009	Calcium	MC
Thallium		Neodymium		Yttrium	<0.0001	Potassium	>0.5
Mercury	NR	Praseodymium	<0.0001	Strontium	0.005	Chlorine	MC
Gold	*0.0001	Cerium	0.0005	Rubidium	0.0008	Sulfur	0.06
Platinum		Lanthanum	0.0004	Bromine	0.001	Phosphorus	0.007
Iridium		Barium	0.004	Selenium		Silicon	MC
Osmium		Cesium		Arsenic	NR	Aluminum	>0.04
Rhenium		Iodine	<0.0001	Germanium	<0.0001	Magnesium	MC
Tungsten		Tellurium		Gallium	0.0006	Sodium	>0.09
Tantalum		Antimony	NR	Zinc	0.006	Fluorine	≈0.3
Hafnium	0.0004	Tin		Copper	0.002	Oxygen	NR
Lutetium		Indium	STD	Nickel	0.01	Nitrogen	NR
Ytterbium		Cadmium	0.0001	Cobalt	0.0003	Carbon	NR
Thulium		Silver	*0.0001	Iron	0.02	Boron	0.2
Erbium		Palladium		Manganese	0.002	Beryllium	
Holmium		Rhodium		Chromium	0.0004	Lithium	0.0005
Dysprosium						Hydrogen	NR

*Heterogeneous

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.0001 $\mu g/cm^2$
MC — Major Component > 1 $\mu g/cm^2$
INT — Interference

Approved:

COMMERCIAL TESTING & ENGINEERING CO.
GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434
Reply to INSTRUMENTAL ANALYSIS DIVISION, 14335 WEST 44TH AVENUE, GOLDEN, COLORADO 80401, PHONE 303-278-9521

To: Mr. Roy A. Belletto
Acurex Corporation
485 Clyde Avenue
Mountain View, CA 94042

Date October 12, 1981

Analyst: J. Oldham

Release No. 6 Exhibit A
P. O. No.: Subcontract No. SW59159A

Sample No. A81-07-011-569

IAD No. 97-H437-116-13

SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS

CONCENTRATION IN PPM WEIGHT

TOSCO 1 XAD

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium		Terbium		Ruthenium		Vanadium	<0.1
Thorium		Gadolinium		Molybdenum	0.2	Titanium	1
Bismuth		Europium		Niobium	<0.1	Scandium	<0.1
Lead	0.2	Samarium		Zirconium	0.2	Calcium	36
Thallium		Neodymium		Yttrium		Potassium	39
Mercury	NR	Praseodymium		Strontium	4	Chlorine	4
Gold		Cerium		Rubidium	<0.1	Sulfur	8
Platinum	0.7	Lanthanum		Bromine	2	Phosphorus	1
Iridium		Barium	2	Selenium		Silicon	9
Osmium		Cesium	<0.1	Arsenic	NR	Aluminum	0.6
Rhenium		Iodine	0.1	Germanium		Magnesium	1
Tungsten		Tellurium		Gallium	<0.1	Sodium	11
Tantalum		Antimony	NR	Zinc	7	Fluorine	<0.1
Hafnium		Tin		Copper	3	Oxygen	NR
Lutetium		Indium	STD	Nickel	9	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	<0.1	Carbon	NR
Thulium		Silver		Iron	6	Boron	<0.1
Erbium		Palladium		Manganese	0.3	Beryllium	
Holmium		Rhodium		Chromium	1	Lithium	<0.1
Dysprosium						Hydrogen	NR

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.1 ppm
MC — Major Component
INT — Interference

Approved: M Jacobs

COMMERCIAL TESTING & ENGINEERING CO.
GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434
Reply to INSTRUMENTAL ANALYSIS DIVISION, 14335 WEST 44TH AVENUE, GOLDEN, COLORADO 80401, PHONE 303-278-9521

To: Mr. Roy A. Belletto
Acurex Corporation
485 Clyde Avenue
Mountain View, CA 94042

Date October 12, 1981

Analyst J. Oldham

P. O. No.: Release No. 6 Exhibit A
Subcontract No. SW59159A

Sample No.: A81-07-011-562

SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS

IAD No.: 97-H437-116-13

TOSCO 2 XAD

CONCENTRATION IN PPM WEIGHT

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium		Terbium		Ruthenium		Vanadium	0.2
Thorium		Gadolinium		Molybdenum	0.9	Titanium	2
Bismuth		Europium		Niobium		Scandium	<0.1
Lead	0.2	Samarium		Zirconium	1	Calcium	150
Thallium		Neodymium		Yttrium		Potassium	250
Mercury	NR	Praseodymium		Strontium	0.5	Chlorine	15
Gold		Cerium		Rubidium	<0.1	Sulfur	74
Platinum	3	Lanthanum		Bromine	5	Phosphorus	8
Iridium		Barium	3	Selenium		Silicon	170
Osmium		Cesium	<0.1	Arsenic	NR	Aluminum	20
Rhenium		Iodine	0.3	Germanium		Magnesium	3
Tungsten		Tellurium		Gallium	<0.1	Sodium	>150
Tantalum		Antimony	NR	Zinc	4	Fluorine	≈0.2
Hafnium		Tin		Copper	8	Oxygen	NR
Lutetium		Indium	STD	Nickel	1	Nitrogen	NR
Ytterbium		Cadmium	0.1	Cobalt	<0.1	Carbon	NR
Thulium		Silver		Iron	32	Boron	<0.1
Erbium		Palladium		Manganese	0.3	Beryllium	
Holmium		Rhodium		Chromium	5	Lithium	<0.1
Dysprosium						Hydrogen	NR

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.1 ppm
MC — Major Component
INT — Interference

Approved: M Jacobs

COMMERCIAL TESTING & ENGINEERING CO.
GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434
Reply to INSTRUMENTAL ANALYSIS DIVISION, 14335 WEST 44TH AVENUE, GOLDEN, COLORADO 80401, PHONE: 303-278-9521

To: Mr. Roy Belleto
Acurex Corporation
485 Clyde Avenue
Mountain View, CA 94042

Date: October 15, 1981

Release No. 6 Exhibit A
P. O. No.: Subcontract No. SW59159A

Analyst: J. Oldham

Sample No.: A81-07-011-580

SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS

IAD No.: 97-H437-116-13

TOSCO XAD BLANK

CONCENTRATION IN PPM WEIGHT

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium		Terbium		Ruthenium		Vanadium	<0.1
Thorium		Gadolinium		Molybdenum	0.3	Titanium	3
Bismuth		Europium		Niobium	<0.1	Scandium	<0.1
Lead	0.3	Samarium		Zirconium		Calcium	71
Thallium		Neodymium		Yttrium		Potassium	15
Mercury	NR	Praseodymium		Strontium	1	Chlorine	1
Gold		Cerium		Rubidium		Sulfur	4
Platinum	*44	Lanthanum	<0.1	Bromine	0.6	Phosphorus	1
Iridium		Barium	*1	Selenium		Silicon	5
Osmium		Cesium		Arsenic	NR	Aluminum	3
Rhenium		Iodine	<0.1	Germanium		Magnesium	1
Tungsten		Tellurium		Gallium	<0.1	Sodium	3
Tantalum		Antimony	NR	Zinc	*5	Fluorine	<0.1
Hafnium		Tin		Copper	2	Oxygen	NR
Lutetium		Indium	STD	Nickel	5	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	<0.1	Carbon	NR
Thulium		Silver		Iron	3	Boron	<0.1
Erbium		Palladium		Manganese	0.2	Beryllium	
Holmium		Rhodium		Chromium	0.3	Lithium	0.1
Dysprosium		*Heterogeneous				Hydrogen	NR

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.1 ppm
MC — Major Component
INT — Interference

Approved: M J Jacobs

COMMERCIAL TESTING & ENGINEERING CO.
GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434
Reply to INSTRUMENTAL ANALYSIS DIVISION, 14335 WEST 44TH AVENUE, GOLDEN, COLORADO 80401, PHONE 303-278-9521

To: Mr. Roy A. Belletto
Acurex Corporation
485 Clyde Avenue
Mountain View, CA 94042

Date October 9, 1981

Release No. 6 Exhibit A
P. O. No.: Subcontract No. SW59159A

Analyst: J. Oldham

Sample No.: A81-07-011-539 SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS

IAD No.: 97-H437-116-13

TOSCO 1 IMP 1

CONCENTRATION IN µg/mL

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	<0.005	Terbium		Ruthenium		Vanadium	0.001
Thorium	<0.006	Gadolinium		Molybdenum	0.006	Titanium	0.08
Bismuth		Europium		Niobium	0.004	Scandium	<0.001
Lead	0.006	Samarium		Zirconium	0.001	Calcium	0.8
Thallium		Neodymium		Yttrium		Potassium	0.8
Mercury	NR	Praseodymium		Strontium	0.005	Chlorine	4
Gold		Cerium		Rubidium	0.003	Sulfur	MC
Platinum		Lanthanum		Bromine	0.01	Phosphorus	0.1
Iridium		Barium	0.03	Selenium	≤0.008	Silicon	9
Osmium		Cesium	0.002	Arsenic	NR	Aluminum	0.02
Rhenium		Iodine	0.003	Germanium		Magnesium	0.03
Tungsten		Tellurium		Gallium	0.002	Sodium	MC
Tantalum		Antimony	NR	Zinc	0.04	Fluorine	≈2
Hafnium		Tin	0.003	Copper	0.04	Oxygen	NR
Lutetium		Indium	STD	Nickel	0.09	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	<0.001	Carbon	NR
Thulium		Silver	*0.7	Iron	0.2	Boron	0.003
Erbium		Palladium		Manganese	0.01	Beryllium	
Holmium		Rhodium		Chromium	0.02	Lithium	<0.001
Dysprosium						Hydrogen	NR

*Heterogeneous

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.001 µg/mL
MC — Major Component > 10 µg/mL
INT — Interference

Approved: M Jacobs

COMMERCIAL TESTING & ENGINEERING CO.
GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434
Reply to INSTRUMENTAL ANALYSIS DIVISION, 14335 WEST 44TH AVENUE, GOLDEN, COLORADO 80401, PHONE 303-278-9521

To: Mr. Roy A. Belletto
Acurex Corporation
485 Clyde Avenue
Mountain View, CA 94042

Date October 12, 1981

Release No. 6 Exhibit A
P. O. No.: Subcontract No. SW59159A

Analyst: J. Oldham

Sample No.: A81-07-011-554

SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS

IAD No.: 97-H437-116-13

TOSCO 1 IMP Δ BLANK

CONCENTRATION IN µg/mL

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	<0.01	Terbium		Ruthenium		Vanadium	0.004
Thorium	<0.02	Gadolinium		Molybdenum	*0.02	Titanium	0.02
Bismuth		Europium		Niobium		Scandium	<0.001
Lead	0.009	Samarium		Zirconium	0.003	Calcium	1
Thallium		Neodymium		Yttrium		Potassium	1
Mercury	NR	Praseodymium		Strontium	0.004	Chlorine	*3
Gold		Cerium		Rubidium	<0.001	Sulfur	0.3
Platinum	0.008	Lanthanum		Bromine	0.04	Phosphorus	0.8
Iridium		Barium	0.009	Selenium		Silicon	*0.7
Osmium		Cesium		Arsenic	NR	Aluminum	0.09
Rhenium		Iodine		Germanium		Magnesium	≤0.02
Tungsten		Tellurium		Gallium		Sodium	0.2
Tantalum		Antimony	NR	Zinc	0.01	Fluorine	≈0.002
Hafnium		Tin	0.02	Copper	0.01	Oxygen	NR
Lutetium		Indium	STD	Nickel	0.008	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	≤0.001	Carbon	NR
Thulium		Silver	0.8	Iron	0.05	Boron	<0.001
Erbium		Palladium		Manganese	0.001	Beryllium	
Holmium		Rhodium		Chromium	0.01	Lithium	<0.001
Dysprosium						Hydrogen	NR

*Heterogeneous

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.002 µg/mL
MC — Major Component > 10 µg/mL
INT — Interference

Approved: M Jacobs

COMMERCIAL TESTING & ENGINEERING CO.

Reply to
GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434
INSTRUMENTAL ANALYSIS DIVISION, 14335 WEST 44TH AVENUE, GOLDEN, COLORADO 80401, PHONE 303-278-9521

To: Mr. Roy Belletto
Acurex Corporation
485 Clyde Street
Mountain View, CA 94042

Date October 14, 1981

Release No. 6 Exhibit A
Subcontract No. SW59159A
P. O. No.:

Analyst J. Oldham

Sample No.: A81-07-011-561

SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS

IAD No. 97-H437-116-13

TOSCO 2 TMP 1

CONCENTRATION IN µg/mL

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium		Terbium		Ruthenium		Vanadium	0.004
Thorium		Gadolinium		Molybdenum	0.009	Titanium	0.06
Bismuth		Europium		Niobium	0.02	Scandium	≤0.002
Lead	0.009	Samarium		Zirconium	0.03	Calcium	1
Thallium		Neodymium		Yttrium	0.002	Potassium	1
Mercury	NR	Praseodymium		Strontium	0.02	Chlorine	0.1
Gold		Cerium	0.009	Rubidium	≤0.02	Sulfur	MC
Platinum		Lanthanum	0.02	Bromine	≤0.03	Phosphorus	0.008
Iridium		Barium	0.08	Selenium	≤0.02	Silicon	3
Osmium		Cesium		Arsenic	NR	Aluminum	0.04
Rhenium		Iodine	≤0.002	Germanium		Magnesium	0.008
Tungsten		Tellurium	≤0.004	Gallium	0.003	Sodium	MC
Tantalum		Antimony	NR	Zinc	0.8	Fluorine	≈0.01
Hafnium		Tin	0.003	Copper	0.2	Oxygen	NR
Lutetium		Indium	STD	Nickel	0.2	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	<0.001	Carbon	NR
Thulium		Silver	0.08	Iron	0.5	Boron	<0.001
Erbium		Palladium		Manganese	0.1	Beryllium	
Holmium		Rhodium		Chromium	0.05	Lithium	<0.001
Dysprosium						Hydrogen	NR

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.001 µg/mL
MC — Major Component > 10 µg/mL
INT — Interference

Approved: M Jacobs

COMMERCIAL TESTING & ENGINEERING CO.
GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434
Reply to INSTRUMENTAL ANALYSIS DIVISION, 14335 WEST 44TH AVENUE, GOLDEN, COLORADO 80401, PHONE 303-278-9521

To: Mr. Roy A. Belletto
Acurex Corporation
485 Clyde Avenue
Mountain View, CA 94042

Date October 12, 1981

Release No. 6 Exhibit A
P. O. No.: Subcontract No. SW59159A

Analyst: J. Oldham

Sample No.: A81-07-011-560

SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS

IAD No. 97-H437-116-13

TOSCO 2 IMP 1 BLANK CONCENTRATION IN µg/mL

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC
Uranium	<0.01	Terbium		Ruthenium		Vanadium	0.001
Thorium	<0.01	Gadolinium		Molybdenum	0.008	Titanium	0.02
Bismuth		Europium		Niobium		Scandium	<0.001
Lead		Samarium		Zirconium	0.002	Calcium	0.9
Thallium		Neodymium		Yttrium		Potassium	*MC
Mercury	NR	Praseodymium		Strontium	0.003	Chlorine	2
Gold		Cerium		Rubidium	0.005	Sulfur	0.5
Platinum		Lanthanum		Bromine	0.01	Phosphorus	1
Iridium		Barium	0.04	Selenium		Silicon	5
Osmium		Cesium	0.006	Arsenic	NR	Aluminum	0.5
Rhenium		Iodine	0.002	Germanium		Magnesium	0.07
Tungsten		Tellurium		Gallium	0.003	Sodium	>4
Tantalum		Antimony	NR	Zinc	0.1	Fluorine	≈0.05
Hafnium		Tin	0.01	Copper	0.02	Oxygen	NR
Lutetium		Indium	STD	Nickel	0.01	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	≤0.002	Carbon	NR
Thulium		Silver	0.03	Iron	0.09	Boron	0.001
Erbium		Palladium		Manganese	0.02	Beryllium	
Holmium		Rhodium		Chromium	0.01	Lithium	0.008
Dysprosium		*Heterogeneous				Hydrogen	NR

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.001 µg/mL
MC — Major Component > 10 µg/mL
INT — Interference

Approved: M J Jacobs

ACUREX Corporation
ANALYSIS LABORATORIES

DATA REPORTING FORM

CUSTOMER CMEA
DATE
CUSTOMER CONTRACT NO. 307605.92
ACUREX CONTRACT NO. A81-07-011
RESULTS REPORT TO L. Waterland
TELEPHONE
ADDRESS
TOSCO

SAMPLE ID (CUSTOMER)	Filter-1	XAD-1	Imp 1-1	Imp 2&3-1	Filter-2	XAD-2	Imp 1-2	Imp 2&3-2	Fly NBS Ash*	
SAMPLE ID (LAB)	545	569	539	555	038	562	561	564	033-6	
PARAMETER										UNITS
Hg Aliquot	3	<2	<1, <1	<1	2	<1	<1,<1	<1	10	ug/1
Hg blank Aliquot	4	3	<1	<1	4	3	<1	<1	<1	ug/1
Hg	<0.07	<0.5	<0.07	<0.07	<0.04	<0.2	<0.01	<0.07	0.10 ug/g	ug/dscm
As Aliquot	-	-	-	<20	-	-	-	<20	-	ug/1
As blank	-	-	-	<20	-	-		<20	-	ug/1
As	-	-	-	<1	-	-	-	<1	-	ug/dscm
Sb Aliquot	-	-	-	<20	-	-	-	<20	-	ug/1
Sb blank	-	-	-	<20	-	-	-	<20	-	ug/1
Sb	-	-	-	<1	-	-	-	<1	-	ug/dscm

*0.16 mg/g Hg

ANALYST

REVIEWER

Form EED-057 4-80

5.7 TOTAL CHROMATOGRAPHABLE ORGANICS (TCO), GRAVIMETRIC ORGANICS (GRAV), INFRARED (IR) SPECTRA, GAS CHROMATOGRAPHY/MASS SPECTROMETRY (GC/MS) AND LOW RESOLUTION MASS SPECTROMETRY (LRMS) OF TOTAL SAMPLE EXTRACTS

ACUREX
Corporation

Energy & Environmental Division

ACUREX
M.S. 2-2260

September 21, 1981
Acurex ID #A81-07-011
#A81-07-033
Client P.O. 307605.92

Attention: L. Waterland

Sample: 2 SASS Train, received 7/8/81

The above referenced samples were analyzed per level 1 protocol. Arsenic and antimony were determined by furnace AAS.

Polynuclears were determined by a modified EPA method 625. 1 ul of sample was injected onto a SE-54, J and W 30 meter capillary column using Grob injection. The column was held at 30°C, then ramped at 10°C per minute to 270°C.

Benzo (c) phenanthrene, dibenzo (c,g) carbozole, 7, 12-dimethylbenz (a) anthracene, 3-methyl chloranthene, and perylene were not detected (<40 ng/ul injection) in any sample analyzed by GC/MS.

The GCMS analysis of XAD-2 resin spiked with 100 mg of naphthalene, phenanthrene, and pyrene gave a recovery of 33% for naphthalene, 38% for phenanthrene, and <1% for pyrene.

Prepared by:
Greg Nicoll
Greg Nicoll
Program Director

Authorized by:
M. C. Ferguson
M. C. Ferguson
Sample Control Custodian

GN/MCF/kfh

ACUREX Corporation
ANALYSIS LABORATORIES

DATA REPORTING FORM

CUSTOMER CMEA
DATE
CUSTOMER CONTRACT NO. 307605.92
ACUREX CONTRACT NO. A81-07-011
RESULTS REPORT TO L. Waterland
TELEPHONE
ADDRESS
TOSCO

SAMPLE ID (CUSTOMER)	Filter-1	XAD-1^a	OMC-1	Filter-2	XAD-2^a	OMC-2	XAD-QC	XAD-1^b	XAD-2^b	
SAMPLE ID (LAB)	545	569	541	038	562	559	033-5	569	567	
PARAMETER										UNITS
GRAV Uncorrected	<6	21	<4	<8	18	6	-			mg
GRAV Blank	<10	10	<4	<10	10	4	-			mg
GRAV	<6	11	<4	<8	8	6				mg
TCO Uncorrected	-	39	<0.04	-	25	0.64	0.74	11	2.3	mg
TCO Blank	-	30	<0.04	-	30	<0.04	<0.02	0.5	0.5	mg
TCO	-	9	<0.04	-	<5	0.64	0.74*	10	1.8	mg
GRAV and TCO	<0.2	0.7	<0.1	<0.3	0.3	0.2	-	0.76	0.35	mg/dscm

*Spiked at 1.00 mg TCO
[a] Contaminated XAD, high blank
[b] Sample/blank contamination corrected by GC/MS

ANALYST
REVIEWER

Form EED-057 4/80

IR REPORT

SAMPLE: Tosco 1 Filter 545

Wave Number (cm^{-1})	Intensity	Assignment	Comments
		No Peaks	

IR REPORT

SAMPLE: Tosco 1 XAD 569

Wave Number (cm^{-1})	Intensity	Assignment	Comments
2920	s	CH Alkane	
2840	s	CH Alkane	

IR REPORT

SAMPLE: Tosco 1 Omc 541

Wave Number (cm⁻¹)	Intensity	Assignment	Comments
		No Peaks	

IR REPORT

SAMPLE: Tosco 2 Filter 038

Wave Number (cm^{-1})	Intensity	Assignment	Comments
		No Peaks	

IR REPORT

SAMPLE: Tosco 2 XAD 562

Wave Number (cm^{-1})	Intensity	Assignment	Comments
		No Peaks	

IR REPORT

SAMPLE: Tosco 2 Omc 559

Wave Number (cm^{-1})	Intensity	Assignment Comments
		No Peaks

IR REPORT

SAMPLE: Tosco Filter Blank 571

Wave Number (cm^{-1})	Intensity	Assignment	Comments
		No Peaks	

IR REPORT

SAMPLE: Tosco XAD Blank

Wave Number (cm^{-1})	Intensity	Assignment Comments
		No Peaks

ACUREX Corporation
ANALYSIS LABORATORIES

DATA REPORTING FORM

CUSTOMER CMEA
DATE
CUSTOMER CONTRACT NO. 307605.92
ACUREX CONTRACT NO. A81-07-011
RESULTS REPORT TO L. Waterland
TELEPHONE
ADDRESS
TOSCO

SAMPLE ID (CUSTOMER)	XAD-1	XAC-2	XAD-2 Dup		XAD-1	XAD-2	XAD-2 Dup			
SAMPLE ID (LAB)	569	562	562DS		569	562	562DS			
PARAMETER										UNITS
Phenol	26	6	14		1.0	0.2	0.55			
Naphthalene (Blank corrected)	<1	9	20		<0.04	0.4	.78			
1,3-Dichlorobenzene	2	<1	<1		0.08	<0.04	<0.04			
1,4-Dichlorobenzene	1	1	2		0.04	0.04	0.08			
1,2-Dichlorobenzene	3	<1	<1		0.1	<0.04	<0.04			
Nitrobenzene	4	1	2		0.2	0.04	0.08			
2-Nitrophenol	<5	11	10		<0.2	0.43	0.39			
Diphenylamine	3	2	2		0.1	0.08	0.08			
Azobenzene	36	<1	1		1.4	<0.04	0.04			
Phenanthrene	30	3	4		1.2	0.1	0.2			
2,6-Dinitrotoluene	<1	3	<1		<0.04	0.1	<0.04			
Other Polynuclears	<1	<1	<1		<0.04	<0.04	<0.04			
Units	ng/ul	ng/ul	ng/ul		ug/dscm	ug/dscm	ug/dscm			

ANALYST

REVIEWER

Form EED-067 4/80

ACUREX
Corporation
LYSIS LABORATORIES

DATA REPORTING FORM

CUSTOMER CMEA
DATE
CUSTOMER CONTRACT NO. 307605.92
ACUREX CONTRACT NO. A81-07-011
RESULTS REPORT TO L. Waterland
TELEPHONE
ADDRESS
TOSCO

SAMPLE ID (CUSTOMER)	Filter-1	Filter-2	Filter Blk	OMC-1	OMC-2	XAD Blk				
SAMPLE ID (LAB)	545	038	571	541	559	580				
PARAMETER	▨	▨	▨	▨	▨	▨	▨	▨	▨	UNITS
Naphthalene	<1	<1	<1	<1	<1	20				ng/ul
Other Polynuclears	<1	<1	<1	<1	<1	<1				ng/ul
Naphthalene	<0.05	<0.08	-	<0.04	<0.04	-				ng/dscm
Other Polynuclears	<0.05	<0.08	-	<0.04	<0.04	-				ng/dscm

ANALYST
REVIEWER

Form EED-057 4/80

Reproduced from best available copy.

ORGANICS ANALYSIS DATA SHEET

LABORATORY NAME Acurex

GCMS Detection Limits

ACID COMPOUNDS

		ng
21A	2,4,6- trichlorophenol	5
22A	p-chloro-m-cresol	5
24A	2- chlorophenol	5
31A	2,4-dichlorophenol	5
34A	2,4- dimethylphenol	5
57A	2- nitrophenol	5
58A	4- nitrophenol	20
59A	2,4- dinitrophenol	20
60A	4,6- dinitro-o-cresol	20
64A	pentachlorophenol	5
* 65A	phenol	1

BASE/NEUTRAL COMPOUNDS

1B	acenaphthene	1
5B	benzidine	20
8B	1,2,4- trichlorobenzene	1
9B	hexachlorobenzene	1
12B	hexachloroethane	1
18B	bis(2-chloroethyl)ether	1
20B	2-chloronaphthalene	1
25B	1,2-dichlorobenzene	1
26B	1,3-dichlorobenzene	1
27B	1,4-dichlorobenzene	1
28B	3,3'-dichlorobenzidine	5
35B	2,4- dinitrotoluene	1
36B	2,6- dinitrotoluene	1
37B	1,2- diphenylhydrazine (as azobenzene)	1
39B	fluoranthene	1
40B	4- chlorophenyl phenyl ether	1

BASE/NEUTRAL COMPOUNDS

		ng
41B	4-bromophenyl phenyl ether	1
42B	bis (2-chloroisopropyl) ether	1
43B	bis (2-chloroethoxy) methane	1
52B	hexachlorobutadiene	1
53B	hexachlorocyclopentadiene	1
54B	isophorone	1
*55B	naphthalene	1
56B	nitrobenzene	1
61B	N-nitrosodimethylamine	NA
62B	N-nitrosodiphenylamine	1
63B	N-nitrosodi-n-propylamine	5
*66B	bis (2-ethylhexyl) phthalate	1
*67B	butyl benzyl phthalate	1
*68B	di-n-butyl phthalate	1
*69B	di-n-octyl phthalate	1
*70B	diethyl phthalate	1
*71B	dimethyl phthalate	1
72B	benzo(a)anthracene	1
73B	benzo(a)pyrene.	1
74B	3,4-benzofluoranthene	1
75B	benzo(k)fluoranthene	1
76B	chrysene	1
77B	acenaphthylene	1
78B	anthracene	1
79B	benzo(ghi)perylene	5
80B	fluorene	1
81B	phenanthrene	1
82B	dibenzo(a,h)anthracene	5
83B	indeno(1,2,3-cd)pyrene	5
84B	pyrene	1

* Normally found in laboratory blanks

ACUREX
Corporation

Energy & Environmental Division

CMEA/ACUREX

December 4, 1981
Acurex ID#: A81-10-011, A81-10-022
Client P.O.#: 307605

ATTENTION: L. Waterland

Samples: 9 extracts from Tosco and Ethan Allen

The above referenced samples were analyzed by direct probe mass spectrometry. Searches have been made for classes of compounds most likely to be found in the various LC fractions, according to procedures described in the "IERL-RTP Procedures Manual: Level 1 Environmental Assessment". The following fragment ions used for search are given below:

Compound Class	Fragment ions (m/e-)
Polycyclic aromatic hydrocarbons	178,202,216,228,252,276
Aliphatic hydrocarbons	57,71
Halogenated aliphatics	79,81,93,95,107,109;49,63
Aromatic hydrocarbons	50,51,77,78,79,91
Ethers	45,59,73
Alcohols	45,59,61,73,75
Phenols	51,77,94
Nitriles	54,68,82
Phthalate esters	61,59,71,87
Amines	44,58
Ketones	51,71
N-heterocyclics	117,167;129,179
Mercaptans, sulfides	47,61,75
Benzothiophenes	57,58,59,69,70,85,97,111,125
Carboxylic acids	60,73,149
Amides	58,72,86,100

To test the analysis procedure, a standard mixture containing ethers, amines, polycyclic aromatic hydrocarbons, nitrosamines, phenols, etc., was analyzed under identical conditions as the samples. Losses of the very volatile compounds such as naphthalene, bis(2-chloroethyl)ether, low molecular weight nitrosamines were observed, however the higher molecular weight compounds in a particular class were recovered.

Prepared by: Greg Nicoll
Greg Nicoll
Program Director

Approved by: Viorica Lopez Avila
Viorica Lopez-Avila, Ph.D.
Technical Director

GN/VLA:es

LRMS REPORT

SAMPLE: Toxco I XAD 569

Major Categories

Intensity	Category	MW Range
100	Ethers	
100	Heterocyclic sulfur compounds	
100	Carboxylic acids	
10	Halogenated aliphatics	
10	Aromatic hydrocarbons	
10	Nitriles	

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition

Other

LRMS REPORT

SAMPLE: Tosco I XAD 569 (cont)

Major Categories

Intensity	Category	MW Range
10	Alcohols	
10	Heterocyclic nitrogen compounds	

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition

Other

LRMS REPORT

SAMPLE: Tosco II XAD 562 and OMC 599

Major Categories

Intensity	Category	MW Range
100	Aliphatic hydrocarbons	
100	Amines	
10	Aromatic hydrocarbons	
10	Carboxylic acids	

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition

Other

5.8 C_1-C_6 CHROMATOGRAMS

TOSCO

Run	Time	Bulb	C_1	C_2	C_3	C_4	C_5	C_6
6/18/81								
Sample 7	1330	A	5.2	ND[a]	ND	ND	ND	ND
Sample 8	1335	B	0.9	ND	0.8	ND	ND	ND
Sample 9	1330	A	1.3	ND	3.0	4.9	0.2	ND
Sample 10	1335	B	ND	ND	1.2	0.2	ND	ND
Cal 11	1627	--	17.0	10.3	10.6	10.8	10.4	10.1
Blank 12	1649	B	2.0	0.3	ND	ND	ND	0.4
Blank 13	1702	A	2.1	ND	ND	ND	ND	ND
Sample 14	1740	B	1.2	0.3	1.5	ND	ND	ND
Sample 15	1750	A	ND	ND	1.4	ND	0.9	ND
Cal 16	1920	--	17.0	10.3	10.6	10.8	10.4	10.1
Sample 17	1945	A	2.5	7.8	5.6	7.0	0.7	ND
Sample 18	1950	B	0.9	8.0	5.6	7.3	ND	ND
Sample 19	1945	A	1.2	3.7	1.6	2.0	2.4	0.2
Sample 20	2055	A	2.3	4.3	1.4	0.9	ND	ND
Blank 24	2155	A	2.1	ND	ND	0.2	ND	ND
Blank 25	2205	B	2.0	ND	ND	ND	ND	ND
6/19/81								
Cal 27,28,29			17.0	10.3	10.6	10.8	10.4	10.1
Sample 30	1110	A	1.1	1.1	0.1	ND	ND	ND
Sample 31	1115	B	1.1	1.8	ND	ND	ND	ND
Sample 32	1115	B	1.1	1.6	ND	0.1	ND	ND
Sample 33	1400	A	1.3	1.8	ND	ND	ND	ND
Sample 34	1405	B	1.0	1.1	ND	ND	ND	ND
[b]Cal 2	1624	--	17.0	10.3	10.6	10.8	10.4	10.1
Sample 3	1645	A	1.5	3.0	ND	0.2	ND	ND
Sample 4	1650	B	0.7	3.0	ND	ND	ND	ND
[b]Cal 1	1621	--	17.1	10.3	10.6	10.8	10.4	10.1
Blank 2	1819	B	1.6	ND	1.4	ND	ND	ND
Blank 3	1831	A	1.3	ND	ND	ND	ND	ND

[a] All values ± 10 percent, less than 0.5 ppm.

[b] Lost power

Note: All values calculated by averaging the before and after (where applicable) calibration amount/area. Values less than 0.1 ppm are ND[a]. Tests run at 110°C, 26 psi through two Varian model 3700 GC packed with 6 ft of Super Q (see appendix A of Volume I for more detail).

TOSCO 6-18-81

	RT	Amount/Area	PPM
Run 1 (Recal B) C_1-C_6			
C_1	0.26	9.1123×10^{-4}	17.0
C_2	0.42	3.4823×10^{-4}	10.3
C_3	0.72	2.2827×10^{-4}	10.6
C_4	1.46	1.6147×10^{-4}	10.8
C_5	3.28	1.3578×10^{-4}	10.4
C_6	7.88	1.1422×10^{-4}	10.1
Run 2 Blank B 1819			
C_1	0.22	1,728	1.6
C_3	0.75	6,076	1.4
Run 2 (Recalibrated B) C_1-C_6			
C_1	0.26	8.9310×10^{-4}	17.0
C_2	0.41	3.4392×10^{-4}	10.3
C_3	0.71	2.1631×10^{-4}	10.6
C_4	1.45	1.4770×10^{-4}	10.8
C_5	3.28	1.2880×10^{-4}	10.4
C_6	7.87	1.1383×10^{-4}	10.1
Run 3 Blank A 1831			
C_1	0.22	1,441	1.3
Run 3 Sample A 1645			
C_1	0.23	1,649	1.5
C_2	0.47	8,656	3.0
C_3	0.96	1,610	0.2
Run 4 Sample B 1650			
C_1	0.23	764	0.7
C_2	0.47	8,548	3.0
C_3	0.96	613	0.09

TOSCO 6-18-81 (Continued)

	RT	Amount/Area	PPM
Run 6 Calibrated C_1-C_6			
C_1	0.24	9.2372×10^{-4}	17.0
C_2	0.41	3.4661×10^{-4}	10.3
C_3	0.70	2.2535×10^{-4}	10.6
C_4	1.42	1.5594×10^{-4}	10.8
C_5	3.22	1.3019×10^{-4}	10.4
C_6	7.74	1.0560×10^{-4}	10.1
Run 7 Sample A 1330			
C_1	0.22	5,888	5.2
Run 8 Sample B 1335			
C_1	0.22	1,069	0.9
C_3	0.47	4,126	0.8
Run 9 Sample A 1330			
C_1	0.22	1,572	1.3
C_3	0.46	15,299	3.0
C_4	0.96	26,831	4.9
	1.33	10,875	
C_5	2.89	1,579	0.2
Run 10 Sample B 1335			
C_1	0.22	0	0
C_3	0.46	6,388	1.2
C_4	0.97	371	0.2
	1.34	867	
Run 11 C_1-C_6 (Recalibrated)			
C_1	0.23	8.3600×10^{-4}	17.0
C_2	0.41	3.0853×10^{-4}	10.3
C_3	0.70	1.6758×10^{-4}	10.6
C_4	1.42	1.0577×10^{-4}	10.8
C_5	3.23	1.2584×10^{-4}	10.4
C_6	7.76	2.1048×10^{-4}	10.1

TOSCO 6-18-81 (Continued)

	RT	Amount/Area	PPM
Run 12 Blank Bulb B 1649			
C_1	0.22	2,286	2.0
C_2	0.37	991	0.3
C_6	3.82	1,231	0.4
	4.99	1,188	
	5.62	274	
Run 13 Blank Bulb A 1702			
C_1	0.22	2,366	2.1
C_4	0.91	57	0.01
Run 14 Sample B 1740			
C_1	0.22	1,371	1.2
C_2	0.31	951	0.3
C_3	0.46	7,432	1.5
Run 15 Sample A 1750			
C_1	0.23	0	0
C_3	0.47	6,885	1.4
C_5	1.75	6,903	0.9
		LOST POWER	
Run 16 (Recalibrated B) 1920			
C_1	0.25	9.2447×10^{-4}	17.0
C_2	0.42	3.5481×10^{-4}	10.3
C_3	0.71	2.3173×10^{-4}	10.6
C_4	1.45	1.5875×10^{-4}	10.8
C_5	3.27	1.3516×10^{-4}	10.4
C_6	7.86	1.2190×10^{-4}	10.1
Run 17 Sample A 1945			
C_1	0.24	2,748	2.5
C_2	0.38	9,701	7.8
	0.46	12,396	
C_3	0.69	24,034	5.6

TOSCO 6-18-81 (Continued)

	RT	Amount/Area	PPM
Run 17 Sample A 1945 Cont.			
C_4	0.96	17,404	7.0
	1.41	26,507	
C_5	2.30	196	0.7
	2.55	1,499	
	2.72	865	
	2.95	1,194	
	2.99	1,530	
C_6	6.03	592	0.07
Run 18 Sample B 1950			
C_1	0.22	1,000	0.9
C_2	0.38	9,514	8.0
	0.45	13,108	
C_3	0.68	24,088	5.6
C_4	0.95	18,656	7.3
	1.37	27,033	
Run 19 Sample A 1945			
C_1	0.21	1,312	1.2
C_2	0.38	3,032	3.7
	0.45	7,373	
C_3	0.69	7,114	1.6
C_4	0.95	2,921	2.0
	1.43	9,483	
C_5	2.14	8,550	2.4
	3.31	9,376	
C_6	5.00	1,717	0.2
$>C_6$	8.63	748	--
Run 20 Sample A 2055			
C_1	0.20	2,526	2.3
C_2	0.37	3,346	4.3
	0.46	8,645	
C_3	0.69	6,058	1.4
C_4	0.95	2,888	0.9
	1.37	2,537	
C_6	4.0	0	0
Run 21, 22, 23 Flame Out			

TOSCO 6-19-81 (Continued)

	RT	Amount/Area	PPM
Run 24 Blank A 2155 Zero Air			
C_1	0.22	2,283	2.1
C_4	1.18	1,277	0.2
C_5	2.38	658	0.09
Run 25 Blank B 2205 Zero Air			
C_1	0.22	2,189	2.0
$>C_6$	9.25	174	--
Run: 27, 28, and 29 (Recalibrated B) C_1-C_6)			
C_1	0.25	9.6424×10^{-4}	17.0
C_2	0.40	3.5852×10^{-4}	10.3
C_3	0.69	2.3319×10^{-4}	10.6
C_4	1.43	1.5990×10^{-4}	10.8
C_5	3.26	1.3517×10^{-4}	10.4
C_6	7.82	1.1796×10^{-4}	10.1
Run 31 Sample B 1115			
C_1	0.22	1,220	1.1
C_2	0.38	666	1.8
	0.47	4,480	
Run 32 Sample B 1115			
C_1	0.22	1,220	1.1
C_2	0.37	680	1.6
	0.47	3,754	
C_4	0.96	665	0.1
Run 33 Sample A 1400			
C_1	0.22	1,409	1.3
C_2	0.46	5,096	1.8
Run 34 Sample B 1405			
C_1	0.22	1,101	1.0
C_2	0.32	331	1.1
	0.46	2,729	
	LOST POWER		

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6-18-81, Time 13:55:57, Instrument ID VARIAN 3700
Recorder/Printout Reference No. 7, Recorder ID HP3390A
Purpose of Run $C_1 - C_6$ HYDROCARBON ANALYSIS

Sample Description 1330 BULB A

GC CONDITIONS

Amount Injected 2.0ML, Inj. Port or Sample Loop Used 2.0ML LOOP
Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ______)
Detector Attenuation 4, Amplifier or Range 10^{-11}
Column: Liquid Phase ______, Solid Phase PORAPAK Q,
Length 6', O.D. 1/8", I.D. ______, Material S.S.
Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C
Temperature Program ISOTHERMAL

SAMPLE RUN

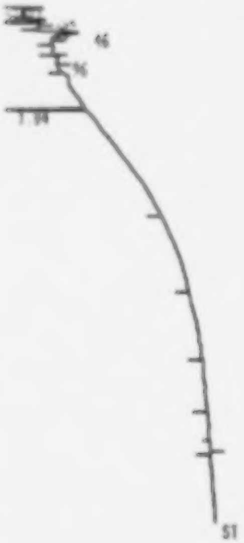
Sampling Method GRAB 500 ML S.S. BULB

RT	Area	Peak Height	Amount (PPM)	Component
.22	5888		5.2	C_1

Name of Operator M.D. CHIPS, Date 9-1 1981

Sample A taken 1330 30psi 310°F
Sample B taken 1336 30psi 275°F

1330 Sample A (265°F)
150°C $\times 10^{-11}$



Operator M. D. CHIPS Date 6-18-81
Column No. Length 6' Dia. 1/8"
Coating Concn.
Support PORAPAK Q Mesh 80/80
TEMP: Col: Init. 150 °C Final 150 °C
Rate °C/min. Det. 250 °C Inj. 120 °C
CARRIER GAS He Rate 60 psi ~~ml./min.~~
Pressures: Inlet Outlet
Hydrogen 40 psi ~~ml./min.~~ Air 60 psi ~~ml./min.~~
DETECTOR E.C. T.C. F.I.D. 1X10⁻¹¹
Scavenger Rate ml./min.
Sens. Rec.Range mv.
SAMPLE 1330 BULB-A Size 2.0ml.
Solvent Concn.

```
RUN #    7              JUN/18/81  13:55:57

ESTD
   RT            AREA TYPE  CAL#        AMOUNT
  0.22           5800   BP    1R         5.439

TOTAL AREA=        5800
MUL FACTOR= 1.0000E+00
```

```
RUN #    7              JUN/18/81  13:55:57

ESTD
   RT            AREA TYPE  CAL#        AMOUNT
  0.22           5800   BP    1R         5.439

TOTAL AREA=        5800
MUL FACTOR= 1.0000E+00
```

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6-18-81, Time 15:40:06, Instrument ID VARIAN 3700
Recorder/Printout Reference No. 8, Recorder ID HP3390A
Purpose of Run $C_1 - C_6$ HYDROCARBON ANALYSIS

Sample Description 1335 BULB-B

GC CONDITIONS

Amount Injected 2.0ML, Inj. Port or Sample Loop Used 2.0ML LOOP
Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ______)
Detector Attenuation 4, Amplifier or Range 10^{-11}
Column: Liquid Phase ______, Solid Phase PORAPAK Q,
Length 6', O.D. 1/8", I.D. ______, Material S.S.
Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C
Temperature Program ISOTHERMAL

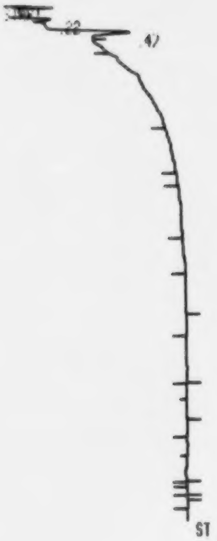
SAMPLE RUN

Sampling Method GRAB 500 ML S.S. BULB

RT	Area	Peak Height	Amount (PPM)	Component
.22	1069		0.9	C_1
.47	4126		0.8	C_3

Name of Operator M.D. CHIPS, Date 9-1 1981

1335 Sample B (<30°F)
150°C 4x10⁻¹¹



Operator M.D. SHiPS Date 6-18-81
Column No. Length 6' Dia. 1/8"
Coating Concn.
Support PORAPAK Q Mesh 60/80
TEMP: Col: Init. 150 °C Final 150 °C
Rate °C/min. Det. 250 °C Inj. 120 °C
CARRIER GAS He Rate 60 PSi ~~ml/min.~~
Pressures: Inlet Outlet
Hydrogen 40 PSi ~~ml/min.~~ Air 60 PSi ~~ml/min.~~
DETECTOR E.C. T.C. F.I.D. 4×10^{-11}
Scavenger Rate ml/min.
Sens. Rec.Range mv.
SAMPLE 1335 BULB-B Size 2.0 ML
Solvent Concn.

```
RUN #    8              JUN/18/81  15:40:06

ESTD
   RT              AREA TYPE   CAL#         AMOUNT
  0.22             1069   PV     1R          0.988

TOTAL AREA=        1069
MUL FACTOR= 1.0000E+00


OP #  6 @
      RPRT UNC PKS        YES

RUN #    8              JUN/18/81  15:40:06

ESTD
   RT              AREA TYPE   CAL#         AMOUNT
  0.22             1069   PV     1R          0.988
  0.47             4126   VB                 0.000

TOTAL AREA=        5195
MUL FACTOR= 1.0000E+00
```

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6-18-81, Time 15:53:30, Instrument ID VARIAN 3700

Recorder/Printout Reference No. 9, Recorder ID HP3390A

Purpose of Run $C_1 - C_6$ HYDROCARBON ANALYSIS

Sample Description 1330 BULB-A

GC CONDITIONS

Amount Injected 2.0 ML, Inj. Port or Sample Loop Used 2.0 ML LOOP

Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ______)

Detector Attenuation 4, Amplifier or Range 10^{-11}

Column: Liquid Phase ______, Solid Phase PORAPAK Q,

Length 6', O.D. 1/8", I.D. ______, Material S.S.

Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C

Temperature Program ISOTHERMAL

SAMPLE RUN

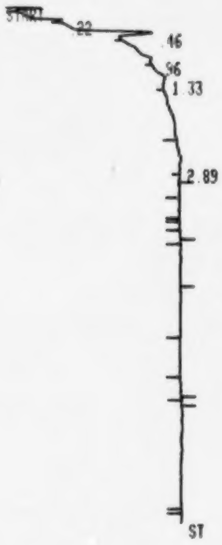
Sampling Method GRAB 500 ML S.S. BULB

RT	Area	Peak Height	Amount (PPM)	Component
.22	1572		1.3	C_1
.46	15299		3.0	C_3
.96	26831		4.9	C_4
1.33	10875			
2.89	1579		0.2	C_5

Name of Operator M.D. CHIPS, Date 9-1 1981

```
LIST: ZERO =  0, 0.0
```

1380 SampleA (243° F)
150 °C 4x10^-11



```
RUN #    9              JUN/18/81   15:53:30

ESTD
  RT            AREA  TYPE   CAL#         AMOUNT
  0.22          1572   PV     1R           1.452
  0.46         15299   VV                  0.000
  0.96         26831   VV                  0.000
  1.33         10875   VB     4R           1.696
  2.89          1579   BV                  0.000

TOTAL AREA=       56156
MUL FACTOR= 1.0000E+00
```

Operator M.D.CHIPS Date 6-18-81
Column No. Length 6' Dia. 1/8"
Coating Concn. Mesh 60/80
Support PORAPAK Q
TEMP: Col: Init 150 °C Final 150 °C
Rate °C/min. Det. 25 °C Inj. 120 °C
CARRIER GAS He Rate 60 psi ~~ml/min.~~
Pressures: Inlet Outlet
Hydrogen 40 psi ~~ml/min.~~ Air 60 psi ~~ml/min.~~
DETECTOR E.C. T.C. F.I.D. 4X10-11
Scavenger Rate ml/min.
Sens. Rec.Range mv.
SAMPLE 1380 BULB-A Size 2.0ml
Solvent Concn.

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6-18-81, Time 1605:19, Instrument ID VARIAN 3700

Recorder/Printout Reference No. 10, Recorder ID HP3390A

Purpose of Run C_1-C_6 HYDROCARBON ANALYSIS

Sample Description 1335 BULB-B

GC CONDITIONS

Amount Injected 2.0ML, Inj. Port or Sample Loop Used 2.0ML LOOP

Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ______)

Detector Attenuation 4, Amplifier or Range 10^{-11}

Column: Liquid Phase ______, Solid Phase PORAPAK Q,

Length 6', O.D. 1/8", I.D. ______, Material S.S.

Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C

Temperature Program ISOTHERMAL

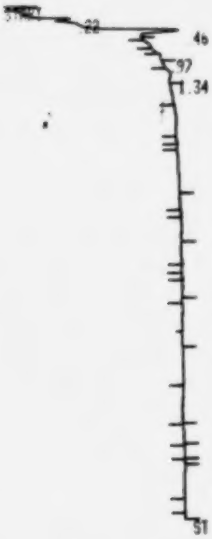
SAMPLE RUN

Sampling Method GRAB 500 ML S.S. BULB

RT	Area	Peak Height	Amount (PPM)	Component
.22	0		0	C_1
.46	6338		1.2	C_3
.97	371		0.2	C_4
1.34	867			

Name of Operator M.D. CHIPS, Date 9-1 1981

1335 Sample B 243°F
[illegible] 4×10^{-11}



Operator M.D. CHIPS Date 6-18-81
Column No. Length 6' Dia. 1/8"
Coating Concn. Mesh 60/80
Support PARAPAK Q
TEMP: Col: Init. 150 °C Final 150 °C
Rate °C/min. Det. 250 °C Inj. 120 °C
CARRIER GAS He Rate 60 psi ~~ml/min.~~
Pressures: Inlet Outlet
Hydrogen 40 psi ~~ml/min.~~ Air 60 psi ~~ml/min.~~
DETECTOR E.C. T.C. F.I.D. 4×10^{-11}
Scavenger Rate ml/min.
Sens. Rec. Range mv.
SAMPLE 1335 Bag B-B Size 2.0 ml
Solvent Concn.

```
RUN #   10             JUN/18/81  16:05:19

ESTD
  RT           AREA TYPE  CAL#        AMOUNT
  0.22            0   PP    1R         0.000
  0.46         6338   PB               0.000
  0.97          371   BB               0.000
  1.34          867   BB    4R         0.135

TOTAL AREA=        7576
MUL FACTOR= 1.0000E+00
```

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6-18-81, Time 16:27:39, Instrument ID VARIAN 3700

Recorder/Printout Reference No. 11, Recorder ID HP3390A

Purpose of Run CALIBRATION

Sample Description SCOTT MULTI-COMPONENT MIXTURE M-PARAFINS ±10%

GC CONDITIONS

Amount Injected 2.0 ML, Inj. Port or Sample Loop Used 2.0 ML LOOP

Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ___)

Detector Attenuation 4, Amplifier or Range 10^{-11}

Column: Liquid Phase ___, Solid Phase PORAPAK Q,

Length 6', O.D. 1/8", I.D. ___, Material S.S.

Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C

Temperature Program ISOTHERMAL

SAMPLE RUN

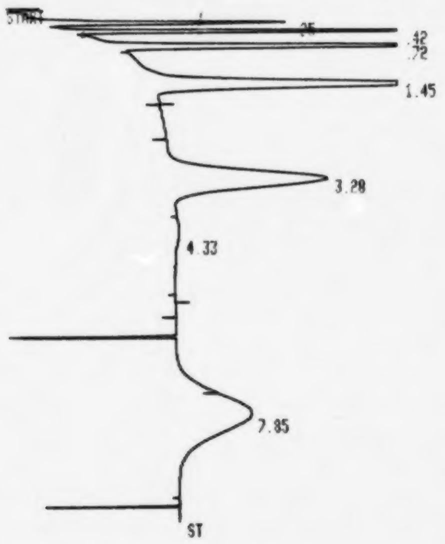
Sampling Method PURGE LOOP

RT	AMT/Area 10^{-4}	Peak Height	Amount PPM	Component
.23	8.3600		17.0	C_1
.41	3.0853		10.3	C_2
.70	1.6758		10.6	C_3
1.42	1.0500		10.8	C_4
3.23	1.2584		10.4	C_5
7.76	2.1048		10.1	C_6

Name of Operator M.D. CHIPS, Date 9-1 1981

$C_1 - C_6$ cal gas 1-J-1

52psi



Operator. M.D. CHIPS .... Date 6-18-81 ....
Column No. .... Length 6' .... Dia. 1/8" ....
Coating .... Concn. ....
Support PORAPAK Q .... Mesh 60/80 ....
TEMP: Col: Init. 150 °C Final 150 °C
Rate .... °C/min. Det 250 °C Inj. 120 °C
CARRIER GAS He .... Rate 60 PSI ml/min.
Pressures: Inlet .... Outlet ....
Hydrogen 40PSI ml/min. Air 60PSI ml/min.
DETECTOR E.C. .... T.C. .... F.I.D 4 x 10-11
Scavenger .... Rate .... ml/min.
Sens. .... Rec.Range .... mv.
SAMPLE CAL #11 .... 1627 .... Size 2.0ml ....
Solvent .... Concn. ....

```
RUN #   11              JUN/18/81  16:27:39

ESTD
  RT          AREA TYPE  CAL#        AMOUNT
  0.25       20335   PV    1R        18.784
  0.42       33384   VV    2R        11.571
  0.72       63253   VV    3R        14.254
  1.45      102110   VB    4R        15.923
  3.28       82646   BV    5R        10.759
  4.33        9046   VV               0.000
  7.85       47986   BP    6R         5.067

TOTAL AREA=     358760
MUL FACTOR= 1.0000E+00
```

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6-18-81, Time 16:49:16, Instrument ID VARIAN 3700

Recorder/Printout Reference No. 12, Recorder ID HP3390A

Purpose of Run C_1-C_6 HYDROCARBON ANALYSIS

Sample Description BLANK BULB-B

GC CONDITIONS

Amount Injected 2.0 ML, Inj. Port or Sample Loop Used 2.0 ML LOOP

Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ___)

Detector Attenuation 4, Amplifier or Range 10^{-11}

Column: Liquid Phase ___, Solid Phase PORAPAK Q,

Length 6', O.D. 1/8", I.D. ___, Material S.S.

Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C

Temperature Program ISOTHERMAL

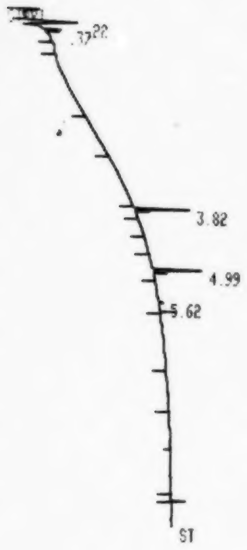
SAMPLE RUN

Sampling Method N_2 PURGE

RT	Area	Peak Height	Amount (PPM)	Component
.22	2286		2.0	C_1
.37	991		0.3	C_2
3.82	1231		0.4	C_6
4.99	1188			
5.62	274			

Name of Operator M.D. CHIPS, Date 9-1 1981

Blank BulB B (236°F) (6psi)
Zero Air pulse
150°C
4x10⁻¹¹
52psi



Operator M.D. Cutlips Date 6-18-81
Column No. Length 6' Dia. 1/8''
Coating Concn.
Support PORAPAK Q Mesh 60/80
TEMP: Col: Init. 150 °C Final 150 °C
Rate °C/min. Det. 250 °C Inj. 120 °C
CARRIER GAS He Rate 60 psi ~~ml/min.~~
Pressures: Inlet Outlet
Hydrogen 40 psi ~~ml/min.~~ Air 60 psi ~~ml/min.~~
DETECTOR E.C. T.C. F.I.D. 4x10⁻¹¹
Scavenger Rate ml/min.
Sens. Rec. Range mv.
SAMPLE BLANK BULB-B Size 2.0 ml
~~Solvent~~ TIME: 16:49 Concn.

```
RUN #   12              JUN/18/81   16:49:16

ESTD
  RT          AREA TYPE  CAL#        AMOUNT
  0.22        2286   BP   1R          1.911
  0.37         991   PB   2R          0.306
  3.82        1231 D PB               0.000
  4.99        1188 D BB               0.000
  5.62         274   BB               0.000

TOTAL AREA=       5970
MUL FACTOR= 1.0000E+00
```

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6-18-81, Time 17:02:55, Instrument ID VARIAN 3700

Recorder/Printout Reference No. 13, Recorder ID HP3390A

Purpose of Run C_1-C_6 HYDROCARBON ANALYSIS

Sample Description BLANK BKGR-A

GC CONDITIONS

Amount Injected 2.0ML, Inj. Port or Sample Loop Used 2.0ML LOOP

Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ___)

Detector Attenuation 4, Amplifier or Range 10^{-11}

Column: Liquid Phase ___, Solid Phase PORAPAK Q,

Length 6', O.D. 1/8", I.D. ___, Material S.S.

Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C

Temperature Program ISOTHERMAL

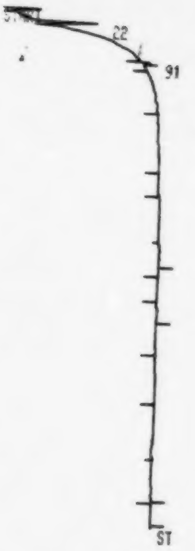
SAMPLE RUN

Sampling Method N_2 PURGE

RT	Area	Peak Height	Amount (ppm)	Component
.22	2366		2.1	C_1
.91	57		.01	C_4

Name of Operator M.D. CHIPS, Date 9-1 1981

Blank Bulb A (279°F 60PSI)
Zero air
150°C 4×10^{-11}



Operator M.D. CHIPS Date 6-18-81
Column No. Length 6' Dia. 1/8"
Coating Concn.
Support PORAPAK Q Mesh 60/80
TEMP: Col: Init. 150 °C Final 150 °C
Rate °C/min. Det 250 °C Inj. 120 °C
CARRIER GAS He Rate 60 PSI ~~ml/min.~~
Pressures: Inlet Outlet
Hydrogen 40 PSI ml./min. Air 60 PSI ~~ml/min.~~
DETECTOR E.C. T.C. F.I.D. 4×10^{-11}
Scavenger Rate ml./min.
Sens. Rec.Range mv.
SAMPLE BLANK BULB-A Size 2.0ml
~~Solvent~~ TIME: 1702 Concn.

```
RUN #   13               JUN/18/81  17:02:35

ESTD
  RT           AREA TYPE  CAL#        AMOUNT
  0.22         2366   PB    1R         1.979
  0.91           57   BB               0.000

TOTAL AREA=       2423
MUL FACTOR= 1.0000E+00
```

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6-18-81, Time 18:10:09, Instrument ID VARIAN 3700

Recorder/Printout Reference No. 14, Recorder ID HP3390A

Purpose of Run $C_1 - C_6$ HYDROCARBON ANALYSIS

Sample Description 1740 BULB-B

GC CONDITIONS

Amount Injected 2.0ML, Inj. Port or Sample Loop Used 2.0ML LOOP

Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ______)

Detector Attenuation 4, Amplifier or Range 10^{-11}

Column: Liquid Phase ______, Solid Phase PORAPAK Q,

Length 6', O.D. 1/8", I.D. ______, Material S.S.

Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C

Temperature Program ISOTHERMAL

SAMPLE RUN

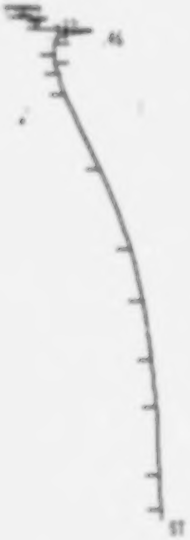
Sampling Method GRAB 500 ML S.S. BULB

RT	Area	Peak Height	Amount (PPM)	Component
.22	1371			
.31	951		1.2	C_1
.46	7432		0.3	C_2
			1.5	C_3

Name of Operator M.D. CHIPS, Date 9-1 1981

1740 Sample B [illegible] 101°F
[illegible] 250°F
21 PSI

GC [illegible]
150°C
1 cm/min



```
RUN #   14              JUN/18/81  10:10:09

ESTD
  RT          AREA TYPE  CAL#         AMOUNT
  0.22        1371   PV    1R          1.146
  0.31         951   VP                0.000
  0.46        7432   PB                0.000

TOTAL AREA=        9754
MUL FACTOR= 1.0000E+00
```

Operator M.D. CHIPS Date 6-18-81
Column No. Length 6' Dia. 1/8"
Coating Concn.
Support PORAPAK Q Mesh 60/80
TEMP: Col: Init. 150 °C Final 150 °C
Rate °C/min. Det. 250 °C Inj. 120 °C
CARRIER GAS He Rate 60 psi ~~ml./min.~~
Pressures: Inlet Outlet
Hydrogen 40 psi ~~ml./min.~~ Air 60 psi ~~ml./min.~~
DETECTOR E.C. T.C. F.I.D. 4 x 10⁻¹¹
Scavenger Rate ml./min.
Sens. Rec. Range mv.
SAMPLE 1740 BULB-B Size 2.0 ml
Solvent Concn.

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6-18-81, Time 18:21:54, Instrument ID VARIAN 3700

Recorder/Printout Reference No. 15, Recorder ID HP3390A

Purpose of Run $C_1 - C_6$ HYDROCARBON ANALYSIS

Sample Description 1750 BULB-A

GC CONDITIONS

Amount Injected 2.0ML, Inj. Port or Sample Loop Used 2.0ML LOOP

Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ________)

Detector Attenuation 4, Amplifier or Range 10^{-11}

Column: Liquid Phase ________, Solid Phase PORAPAK Q,

Length 6', O.D. 1/8", I.D. ________, Material S.S.

Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C

Temperature Program ISOTHERMAL

SAMPLE RUN

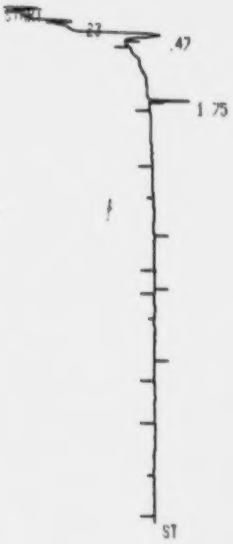
Sampling Method GRAB 500 ML S.S. BULB

RT	Area	Peak Height	Amount (ppm)	Component
.23	0		—	C_1
.47	6885		1.4	C_3
1.75	6903		0.9	C_5

Name of Operator M.D. CHIPS, Date 9-1 1981

1750 Sample A taken 240°F
Anal. 267°F

150°C
4x10-11



Operator M.D. CHIPS Date 6-18-81
Column No. Length 6' Dia. 1/8"
Coating Concn.
Support Porapak Q Mesh 60/80
TEMP: Col: Init. 150 °C Final 150 °C
Rate °C/min. Det. 250 °C Inj. 190 °C
CARRIER GAS He Rate 60psi ~~ml/min.~~
Pressures: Inlet Outlet
Hydrogen 40psi ~~ml/min.~~ Air 60psi ~~ml/min.~~
DETECTOR E.C. T.C. F.I.D. 4 x 10-11
Scavenger Rate ml/min.
Sens. Rec.Range mv.
SAMPLE 1750 BULB-A Size 2.0 ml.
Solvent Concn.

```
RUN #   15            JUN/18/81   18:21:54

ESTD
  RT            AREA  TYPE   CAL#        AMOUNT
  0.23             0   PP     1R          0.000
  0.47          6885   PB                 0.000
  1.75          6903 D BB                 0.000

TOTAL AREA=       13788
MUL FACTOR= 1.0000E+00
```

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6-18-81, Time 19:20:59, Instrument ID VARIAN 3700

Recorder/Printout Reference No. 16, Recorder ID HP3390A

Purpose of Run CALIBRATION

Sample Description SCOTT MULTI-COMPONENT MIXTURE N-PARAFINS ±10%

GC CONDITIONS

Amount Injected 2.0 ML, Inj. Port or Sample Loop Used 2.0ML LOOP

Detector Used: FID X, ECD __, FPD __, TCD __ (Current ____)

Detector Attenuation 4, Amplifier or Range 10^{-11}

Column: Liquid Phase ____, Solid Phase PORAPAK Q,

Length 6', O.D. 1/8", I.D. ____, Material S.S.

Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C

Temperature Program ISOTHERMAL

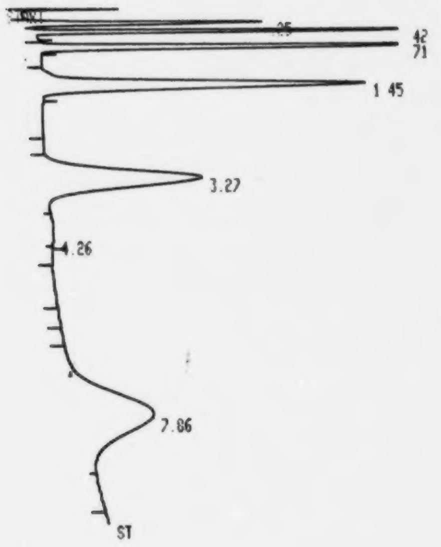
SAMPLE RUN

Sampling Method PURGE LOOP

RT	~~mm~~Area 10^{-4}	Peak Height	Amount PPM	Component
.25	9.2447		17.0	C_1
.42	3.5481		10.3	C_2
.71	2.3173		10.6	C_3
1.45	1.5875		10.8	C_4
3.27	1.3516		10.4	C_5
7.86	1.2190		10.1	C_6

Name of Operator M.D. CHIPS, Date 9-1 1981

C_1-C_6 cal 995
1-T-1



Operator M.D. C#1 P.S Date 6-18-81
Column No. Length 6' Dia. 1/8"
Coating Concn.
Support Poropak Q Mesh 80/80
TEMP: Col: Init. 150 °C Final 150 °C
Rate °C/min. Det. 250 °C Inj. 120 °C
CARRIER GAS He Rate 60 PSI ~~ml/min.~~
Pressures: Inlet Outlet
Hydrogen 40 PSI ~~ml/min.~~ Air 60 PSI ~~ml/min.~~
DETECTOR E.C. T.C. F.I.D.
Scavenger Rate ml/min.
Sens. Rec. Range mv.
SAMPLE CAL #16 1920 Size 2.0 ml
Solvent Concn.

```
RUN #   16              JUN/18/81  19:20:39

ESTD
  RT            AREA TYPE  CAL#        AMOUNT
  0.25         18389   BV    1R        15.373
  0.42         29030   VB    2R         8.957
  0.71         45742   BB    3R         7.666
  1.45         68033   PB    4R         7.196
  3.27         76947   BV    5R         9.683
  4.26          1719   VV               0.000
  7.86         82853   PB    6R        17.439

TOTAL AREA=      322710
MUL FACTOR= 1.0000E+00
```

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6-18-81, Time 20:01:20, Instrument ID VARIAN 3700

Recorder/Printout Reference No. 17, Recorder ID HP3390A

Purpose of Run $C_1 - C_6$ HYDROCARBON ANALYSIS

Sample Description 19:45 BULB-A

GC CONDITIONS

Amount Injected 2.0ML, Inj. Port or Sample Loop Used 2.0ML LOOP

Detector Used: FID X, ECD __, FPD __, TCD __ (Current ____)

Detector Attenuation 4, Amplifier or Range 10^{-11}

Column: Liquid Phase ____, Solid Phase PORAPAK Q,

Length 6', O.D. 1/8", I.D. ____, Material S.S.

Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C

Temperature Program ISOTHERMAL

SAMPLE RUN

Sampling Method GRAB 500 ML S.S. BULB

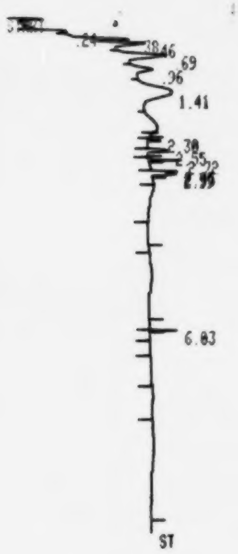
RT	~~Amt~~/Area $10.^{-4}$	Peak Height	Amount (ppm)	Component
.24	2.748		2.5	C_1
.38	9.701	)	7.8	) C_2
.46	1.2346			
.69	2.4034		5.6	C_3
.96	1.7404	)	7.0	) C_4
1.41	26507			

↳ CONTINUED ON NEXT PAGE

Name of Operator M.D. CHIPS, Date 9-1 1981

RT	Amt/Area 10^{-4}	Peak Height	Amount (ppm)	Component
2.30	196			
2.55	1499			
2.72	865		0.7	C_5
2.95	1194			
2.99	1530			
6.03	592		0.07	C_6

1945 Sample A 275°F
Anal 225°F



Operator M.D. CHIPS Date 6-18-81
Column No. Length 6' Dia. 1/8"
Coating Concn.
Support PORAPAK Q Mesh 60/80
TEMP: Col: Init. 150 °C Final 150 °C
Rate °C/min. Det. 250 °C Inj. 120 °C
CARRIER GAS He Rate 60 psi ~~ml/min.~~
Pressures: Inlet Outlet
Hydrogen 40 psi ~~ml/min.~~ Air 60 psi ~~ml/min.~~
DETECTOR E.C. T.C. F.I.D. 4 x 10-11
Scavenger Rate ml/min.
Sens. Rec. Range mv.
SAMPLE 1945 BULB-A Size 2.0 ml
Solvent Concn.

```
RUN #   17              JUN/18/81  20:01:20

ESTD
  RT             AREA TYPE  CAL#        AMOUNT
  0.24           2748   BV    1R         2.540
  0.38           9701   VV    2R         3.442
  0.46          12396   VV               0.000
  0.69          24034   VV    3R         5.570
  0.96          17404   VV               0.000
  1.41          26507   VB    4R         4.208
  2.30            196 D BB               0.000
  2.55           1499   BB               0.000
  2.72            865 D PB               0.000
  2.95           1194   BV               0.000
  2.99           1530 D VB    5R         0.207
  6.03            592 D BB               0.000

TOTAL AREA=       98666
MUL FACTOR= 1.0000E+00
```

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6-18-81, Time 20:12:58, Instrument ID VARIAN 3700

Recorder/Printout Reference No. 18, Recorder ID HP3390A

Purpose of Run $C_1 - C_6$ HYDROCARBON ANALYSIS

Sample Description 1950 BULB-B

GC CONDITIONS

Amount Injected 2.0ML, Inj. Port or Sample Loop Used 2.0ML LOOP

Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ________)

Detector Attenuation 4, Amplifier or Range 10^{-11}

Column: Liquid Phase ________, Solid Phase PORAPAK Q,

Length 6', O.D. 1/8", I.D. ________, Material S.S.

Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C

Temperature Program ISOTHERMAL

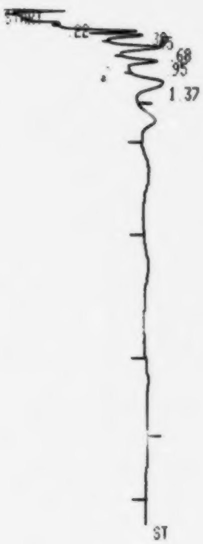
SAMPLE RUN

Sampling Method GRAB 500 ML S.S. BULB

RT	Area	Peak Height	Amount (PPM)	Component
.22	1000		0.9	C_1
.38	9514		8.0	C_2
.45	13108			
.68	24088		5.6	C_3
.95	18656		7.3	C_4
1.37	27033			

Name of Operator M.D. CHIPS, Date 9-1 1981

1950 Sample B 295°F
Anal 260°F



Operator M.D. CHIPS Date 6-18-81
Column No. Length 6' Dia. 1/8"
Coating Concn.
Support PORAPAK Q Mesh 60/80
TEMP: Col: Init. 150 °C Final 150 °C
Rate °C/min. Det. 250 °C Inj. 120 °C
CARRIER GAS He Rate 60 psi ~~ml/min.~~
Pressures: Inlet Outlet
Hydrogen 40 psi ~~ml/min.~~ Air 60 psi ~~ml/min.~~
DETECTOR E.C. T.C. F.I.D. 4 x 10⁻¹¹
Scavenger Rate ml/min.
Sens. Rec.Range mv.
SAMPLE 1950 BULB-B Size 2.0 mL
Solvent Concn.

```
RUN #   18             JUN/18/81  20:12:58

ESTD
  RT            AREA TYPE  CAL#        AMOUNT
  0.22          1000   PV    1R         0.925
  0.38          9514   VV               0.000
  0.45         13108   VV    2R         4.651
  0.68         24088   VV    3R         5.582
  0.95         18656   VV               0.000
  1.37         27033   VB    4R         4.291

TOTAL AREA=       93399
MUL FACTOR= 1.0000E+00
```

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6-18-81, Time 20:32:22, Instrument ID VARIAN 3700

Recorder/Printout Reference No. 19, Recorder ID HP3390A

Purpose of Run C_1-C_6 HYDROCARBON ANALYSIS

Sample Description 1945 BULB-A

GC CONDITIONS

Amount Injected 2.0ML, Inj. Port or Sample Loop Used 2.0ML LOOP

Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ________)

Detector Attenuation 4, Amplifier or Range 10^{-11}

Column: Liquid Phase ________, Solid Phase PORAPAK Q,

Length 6', O.D. 1/8", I.D. ________, Material S.S.

Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C

Temperature Program ISOTHERMAL

SAMPLE RUN

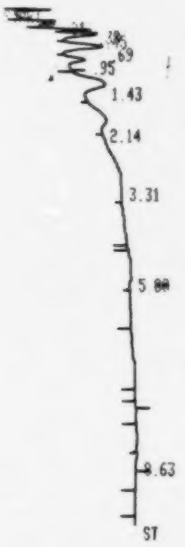
Sampling Method GRAB 500 ML S.S. BULB

RT	Area	Peak Height	Amount (ppm)	Component
.21	1312		1.2	C_1
.38	3032		3.7	C_2
.45	7373			
.69	7114		1.6	C_3
.95	2921		2.0	C_4
1.43	9483			

Name of Operator M.D. CHIPS, Date 9-1 1981

RT	Area	Peak Height	Amount (ppm)	Component
2.14	8550	)	2.4	) C5
3.31	9376			
5.00	1717		.02	C6
8.63	748			> C6

1945 Sample A (repeat)



Operator M.D. CHIPS Date 6-18-81
Column No. Length 6' Dia. 1/8"
Coating Concn.
Support PORAPAK Q Mesh 60/80
TEMP: Col: Init. 150 °C Final 150 °C
Rate °C/min. Det. 250 °C Inj. 120 °C
CARRIER GAS He Rate 60psi ~~ml/min.~~
Pressures: Inlet Outlet
Hydrogen 40 psi ~~ml/min.~~ Air 60 psi ~~ml/min.~~
DETECTOR E.C. T.C. F.I.D. 4 x 10⁻¹¹
Scavenger Rate ml/min.
Sens. Rec. Range mv.
SAMPLE 1945 Bolb-A Size 2.0 ml
Solvent Concn.

```
RUN #   19             JUN/18/81  20:32:22

ESTD
  RT           AREA  TYPE   CAL#        AMOUNT
  0.21         1312   PB     1R          1.213
  0.38         3032   PV                 0.000
  0.45         7373   VV     2R          2.616
  0.69         7114   VV     3R          1.649
  0.95         2921   VB                 0.000
  1.43         9483   BV     4R          1.505
  2.14         8550   VV                 0.000
  3.31         9376   VB     5R          1.267
  5.00         1717   BB                 0.000
  8.63          748   PB                 0.000

TOTAL AREA=       51626
MUL FACTOR= 1.0000E+00
```

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6-18-81, Time 21:09:12, Instrument ID VARIAN 3700
Recorder/Printout Reference No. 20, Recorder ID HP3390A
Purpose of Run C_1-C_6 HYDROCARBON ANALYSIS
Sample Description 2055 BULB-A

GC CONDITIONS

Amount Injected 2.0 ML, Inj. Port or Sample Loop Used 2.0 ML LOOP
Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ______)
Detector Attenuation 4, Amplifier or Range 10^{-11}
Column: Liquid Phase ______, Solid Phase PORAPAK Q,
Length 6', O.D. 1/8", I.D. ______, Material S.S.
Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C
Temperature Program ISOTHERMAL

SAMPLE RUN

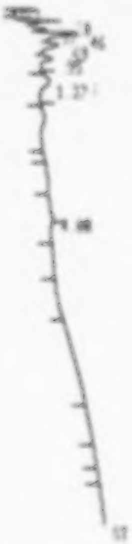
Sampling Method GRAB 500 ML S.S. BULB

RT	Area	Peak Height	Amount (ppm)	Component
.20	2526		2.3	C_1
.37	3346		4.3	C_2
.46	8645			
.69	6058		1.4	C_3
.95	2888		0.9	C_4
1.37	2537			
4.00	0		0	C_6

Name of Operator M.D. CHIPS, Date 9-1 1981

2055 Sample A (Tedlar 280°F
Anal 280°F
21:15?)

150°C
62 PSI
6ULS-A



Operator M.D. Chips Date 6-18-81
Column No. Length 6' Dia. 1/8"
Coating Concn.
Support Porapak Q Mesh 80/100
TEMP: Col. Int. 150 °C Final 150 °C
Rate °C/min. Det. 250 °C Inj. 120 °C
CARRIER GAS He Rate 60 psi ~~ml/min.~~
Pressures: Inlet Outlet
Hydrogen 40 psi ~~ml/min.~~ Air 60 psi ~~ml/min.~~
DETECTOR E.C. T.C. F.I.D. 4x10-12
Scavenger Rate ml/min.
Sens. Rec. Range mv.
SAMPLE 2055 6ULS-A Size 2.0 mL
Solvent Concn.

```
RUN #   28              JUN/18/81  21:09:12

ESTD
   RT            AREA TYPE   CAL#         AMOUNT
   0.20          2526   BV                 0.000
   0.37          3344   VV     2R          1.187
   0.46          1645   VV                 0.000
   0.63          6058   VV     3R          1.404
   0.95          2080   VB                 0.000
   1.27          2537   BB     4R          0.401
   4.00             0   PB                 0.000

TOTAL AREA=      26000
MUL FACTOR= 1.0000E+00
```

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6-18-81, Time 21:55:18, Instrument ID VARIAN 3700
Recorder/Printout Reference No. 24, Recorder ID HP3390A
Purpose of Run C_1-C_6 HYDROCARBON ANALYSIS

Sample Description 2155 BULB-A

GC CONDITIONS

Amount Injected 2.0ML, Inj. Port or Sample Loop Used 2.0ML LOOP
Detector Used: FID X, ECD __, FPD __, TCD __ (Current ____)
Detector Attenuation 4, Amplifier or Range 10^{-11}
Column: Liquid Phase ____, Solid Phase PORAPAK Q,
Length 6', O.D. 1/8", I.D. ____, Material S.S.
Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C
Temperature Program ISOTHERMAL

SAMPLE RUN

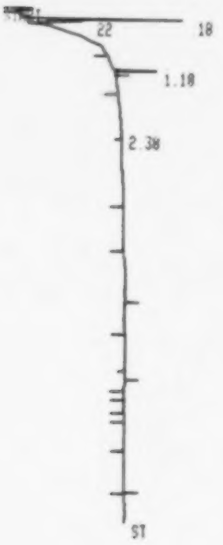
Sampling Method GRAB 500 ML S.S. BULB

RT	Area	Peak Height	Amount (ppm)	Component
.22	2283		2.1	C_1
1.18	1277		0.2	C_4
2.38	658		0.09	C_5

Name of Operator M.D. CHIPS, Date 9-1 1981

Sample Bulb A 245F
Zero Air Blank 60PSI

LIST: ZERO = 0, 0.0



Operator M.D. Chips Date 6-18-81
Column No. Length 6' Dia. 1/8"
Coating Concn.
Support Poropak Q Mesh 80/100
TEMP: Col: Init. 150 °C Final 150 °C
Rate °C/min. Det. 250 °C Inj. 120 °C
CARRIER GAS He Rate 60 PSI ~~ml/min.~~
Pressures: Inlet Outlet
Hydrogen 40 PSI ~~ml/min.~~ Air 60 PSI ~~ml/min.~~
DETECTOR E.C. T.C. F.I.D. 4×10⁻¹¹
Scavenger Rate ml/min.
Sens. Rec. Range mv.
SAMPLE 2155 Bulb-A Size 2.0 ml.
Solvent Concn.

```
RUN #   24                 JUN/18/81  21:55:18

ESTD
  RT           AREA TYPE  CAL#        AMOUNT
  0.18         3219 D PV               0.000
  0.22         2283   VB    1R         2.111
  1.18         1277 D BB               0.000
  2.38          658   PB               0.000

TOTAL AREA=       7437
MUL FACTOR= 1.0000E+00
```

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6-18-81, Time 22:05:57, Instrument ID VARIAN 3700

Recorder/Printout Reference No. 25, Recorder ID HP3390A

Purpose of Run C_1-C_6 HYDROCARBON ANALYSIS

Sample Description 2205 BULB-B

GC CONDITIONS

Amount Injected 2.0ML, Inj. Port or Sample Loop Used 2.0ML LOOP

Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ________)

Detector Attenuation 4, Amplifier or Range 10^{-11}

Column: Liquid Phase ________, Solid Phase PORAPAK Q,

Length 6', O.D. 1/8", I.D. ________, Material S.S.

Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C

Temperature Program ISOTHERMAL

SAMPLE RUN

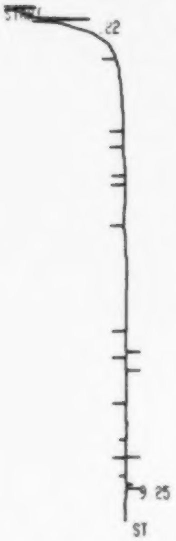
Sampling Method GRAB 500 ML S.S. BULB

RT	Area	Peak Height	Amount (ppm)	Component
.22	2189		2.0	C_1
9.25	174		—	$>C_6$

Name of Operator M.D. CHIPS, Date 9-1 1981

Blank Sample Bulb B 240°F
Zero Air 60 PSI

```
LIST: ZERO =  0,-0.1
```



```
RUN #   25              JUN/18/81  22:05:57

ESTD
  RT           AREA TYPE  CAL#       AMOUNT
  0.22         2189   PB    1R        2.024
  9.25          174 D PB              0.000

TOTAL AREA=        2363
MUL FACTOR= 1.0000E+00
```

Operator M.D. Chips Date 6-18-81
Column No. Length 6' Dia. 1/8"
Coating Concn.
Support Porapak Q Mesh 60/80
TEMP: Col: Init 150 °C Final 150 °C
Rate °C/min. Det 250 °C Inj 120 °C
CARRIER GAS He Rate 60 psi ~~ml/min~~
Pressures: Inlet Outlet
Hydrogen 40 psi ~~ml/min.~~ Air 60 psi ~~ml/min.~~
DETECTOR E.C. T.C. F.I.D. 4×10 -11
Scavenger Rate ml./min.
Sens. Rec.Range mv.
SAMPLE 2205 Bulb-B Size 2.0 mL
Solvent Concn.

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6-17-81, Time 09:58:08, Instrument ID VARIAN 3700

Recorder/Printout Reference No. 27, Recorder ID HP3390A

Purpose of Run CALIBRATION

Sample Description SCOTT MULTI-COMPONENT MIXTURE (M-PARAFINS ±10%

GC CONDITIONS

Amount Injected 2.0ML, Inj. Port or Sample Loop Used 2.0ML LOOP

Detector Used: FID X, ECD __, FPD __, TCD __ (Current ______)

Detector Attenuation 4, Amplifier or Range 10^{-11}

Column: Liquid Phase ______, Solid Phase PORAPAK Q,

Length 6', O.D. 1/8", I.D. ______, Material S.S.

Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C

Temperature Program ISOTHERMAL

SAMPLE RUN

Sampling Method PURGE LOOP

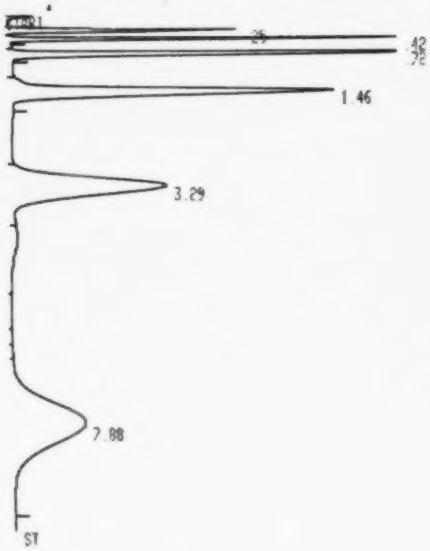
RT	AMT/Area 10^{-4}	Peak Height	Amount PPM	Component
.25	9.6424		17.0	C_1
.40	3.5852		10.3	C_2
.69	2.3319		10.6	C_3
1.43	1.5990		10.8	C_4
3.26	1.3517		10.4	C_5
7.82	1.1796		10.1	C_6

Name of Operator M.D. CHIPS, Date 9-1 1981

Reproduced from
best available copy.

Cal C_1-C_6 1-T-1

```
LIST: ZERO =  0, 0.0
```



```
RUN #   27              JUN/19/81  09:58:08

ESTD
  RT           AREA  TYPE   CAL#          AMOUNT
  0.25        17870   BP                   0.000
  0.42        28720   PB     2R           10.190
  0.72        45643   BB     3R           10.577
  1.46        67818   BB     4R           10.766
  3.29        76621   BB     5R           10.356
  7.88        87186   BB     6R           10.628

TOTAL AREA=       323860
MUL FACTOR=  1.0000E+00
```

Operator. M. D. CHIPS ..... Date. 6-19-81
Column No. .... Length. 6' ...... Dia. 1/8"
Coating .... Concn. ....
Support. PORAPAK Q .... Mesh ....
TEMP: Col: Init. .... 150 °C Final. 150 ..... °C
Rate ...... °C/min. Det. 250 ..... °C Inj. 120 ..... °C
CARRIER GAS .... He .... Rate. 60 psi .... ~~ml/min.~~
Pressures: Inlet. .... Outlet. ....
Hydrogen. 40 psi ...... ~~ml/min.~~ Air. 60 psi ...... ~~ml/min.~~
DETECTOR E.C. .... T.C. .... F.I.D. 4 x 10 -11 ....
Scavenger. .... Rate. .... ml/min.
Sens. .... Rec. Range. .... mv.
SAMPLE. CAL # 27 .... 0958 .... Size. 2.0 ....
Solvent. .... Concn. ....

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6-19-81, Time 10:15:15, Instrument ID VARIAN 3700

Recorder/Printout Reference No. 28, Recorder ID HP3390A

Purpose of Run CALIBRATION

Sample Description SCOTT MULTI-COMPONENT MIXTURE N-PARAFINS ±10%

GC CONDITIONS

Amount Injected 2.0ML, Inj. Port or Sample Loop Used 2.0ML LOOP

Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current _____)

Detector Attenuation 4, Amplifier or Range 10^{-11}

Column: Liquid Phase _____, Solid Phase PORAPAK Q,

Length 6', O.D. 1/8", I.D. _____, Material S.S.

Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C

Temperature Program ISOTHERMAL

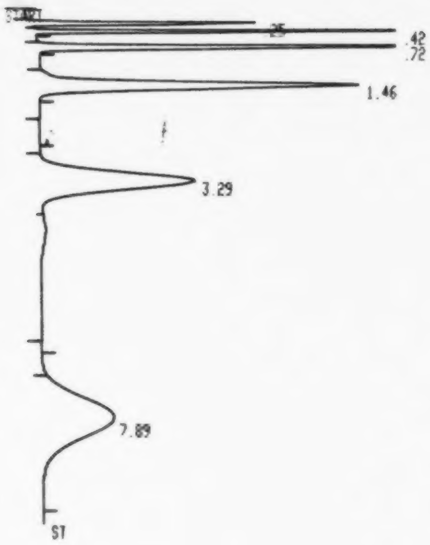
SAMPLE RUN

Sampling Method PURGE LOOP

RT	mmT/Area 10^{-4}	Peak Height	Amount PPM	Component
.25	96424		17.0	C_1
.40	35852		10.3	C_2
.69	2.3319		10.6	C_3
1.43	1.5990		10.8	C_4
3.26	1.3517		10.4	C_5
7.82	1.1796		10.1	C_6

Name of Operator M.D. CHIPS, Date 9-1 1981

C_1-C_6 cal



```
RUN #   28              JUN/19/81  10:15:15

ESTD
  RT          AREA TYPE  CAL#        AMOUNT
  0.25       17459  PV    1          16.609
  0.42       28710  VB    2R         10.296
  0.72       45423  BB    3R         19.549
  1.46       67497  BB    4R         10.749
  3.29       76372  BB    5R         10.366
  7.89       84110  BB    6R          9.744

TOTAL AREA=      319570
MUL FACTOR= 1.0000E+00
```

Operator M.D. CHIPS Date 6-19-81
Column No. Length 6' Dia. 1/8"
Coating Concn.
Support PORAPAK Q Mesh 60/80
TEMP: Col: Init. 150 °C Final 150 °C
Rate °C/min. Det 250 °C Inj. 120 °C
CARRIER GAS He Rate 60 PSI ~~ml./min.~~
Pressures: Inlet Outlet
Hydrogen 40 PSI ~~ml./min.~~ Air 60 PSI ~~ml./min.~~
DETECTOR E.C. T.C. F.I.D. 4 X10⁻¹¹
Scavenger Rate ml./min.
Sens. Rec.Range mv.
SAMPLE CAL # 28 1015 Size 2.0 ML
Solvent Concn.

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6-17-81, Time 10:27:17, Instrument ID VARIAN 3700
Recorder/Printout Reference No. 29, Recorder ID HP3390A
Purpose of Run CALIBRATION

Sample Description SCOTT MULTI-COMPONENT MIXTURE n-PARAFINS ±10%

GC CONDITIONS

Amount Injected 2.0 mL, Inj. Port or Sample Loop Used 2.0 mL Loop
Detector Used: FID X, ECD __, FPD __, TCD __ (Current ______)
Detector Attenuation 4, Amplifier or Range 10^{-11}
Column: Liquid Phase ______, Solid Phase PORAPAK Q,
Length 6', O.D. 1/8", I.D. ______, Material S.S.
Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C
Temperature Program ISOTHERMAL

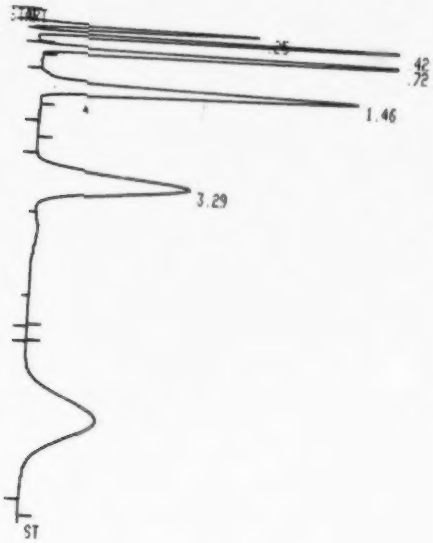
SAMPLE RUN

Sampling Method PURGE LOOP

RT	Area 10^{-4}	Peak Height	Amount PPM	Component
.25	1.7567		17.0	C_1
.42	2.8757		10.3	C_2
.72	4.5304		10.6	C_3
1.46	6.7312		10.8	C_4
3.29	7.7845		10.4	C5
—			10.1	C6

Name of Operator M.D. CHIPS, Date 9-1 1981

$C_1 - C_6$ cal



```
RUN #   29
                       JUN/19/81  10:27:17
ESTD
  RT
  0.25          AREA  TYPE  CAL#        AMOUNT
  0.42         17567   PV    1          16.908
  0.72         28757   VB     2R        10.315
  1.46         45304   BB    3R         10.547
  3.29         67312   BB    4R         10.745
               77845   BV    5R         10.583

TOTAL AREA=      236790
MUL FACTOR= 1.0000E+00
```

Operator M.D. CHIPS Date 6-19-81
Column No. Length 6' Dia. 1/8"
Coating Concn.
Support PORAPAK Q Mesh 60/80
TEMP: Col: Init. 150 °C Final 150 °C
Rate °C/min. Det. 250 °C Inj. 120 °C
CARRIER GAS He Rate 60 PSI ~~ml/min.~~
Pressures: Inlet Outlet
Hydrogen 40 PSI ~~ml/min.~~ Air 60 PSI ~~ml/min.~~
DETECTOR E.C. T.C. F.I.D. 4 X 10⁻¹¹
Scavenger Rate ml/min.
Sens. Rec.Range mv.
SAMPLE CAL # 29 10:27 Size 2.0 ML
Solvent Concn.

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6-19-81, Time 11:2402, Instrument ID VARIAN 3700

Recorder/Printout Reference No. 30, Recorder ID HP3390A

Purpose of Run $C_1 - C_6$ HYDROCARBON ANALYSIS

Sample Description 111D BULB-A

GC CONDITIONS

Amount Injected 2.0ML, Inj. Port or Sample Loop Used 2.0ML LOOP

Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ______)

Detector Attenuation 4, Amplifier or Range 10^{-11}

Column: Liquid Phase ______, Solid Phase PORAPAK Q,

Length 6', O.D. 1/8", I.D. ______, Material S.S.

Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C

Temperature Program ISOTHERMAL

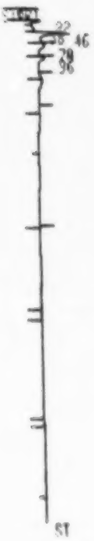
SAMPLE RUN

Sampling Method GRAB 500 ML S.S. BULB

RT	Area	Peak Height	Amount (PPM)	Component
.22	1194		1.1	C_1
.38	738		1.1	C_2
.46	2459			
.70	479		0.1	C3
.96	596		0.09	C4

Name of Operator M.D. CHIPS, Date 9-1 1981

1110 Sample A Taken 265°F
Anal 285°F
GC 120
150 4×10^{-11}
250



```
RUN #   30             JUN/19/81  11:24:02

ESTD
  RT          AREA TYPE  CAL#        AMOUNT
  0.22        1194   PV    1          1.151
  0.38         738   VV   2R          0.265
  0.46        2459   VB               0.000
  0.70         479   BB   3R          0.112
  0.96         596   BB               9.000

TOTAL AREA=       5466
MUL FACTOR= 1.0000E+00
```

Operator M.D. Griies Date 6-19-81
Column No. Length 6' Dia. 1/8"
Coating Concn.
Support PORAPAK Q Mesh 60/80
TEMP: Col: Init. 150 °C Final 150 °C
Rate °C/min. Det. 250 °C Inj. 120 °C
CARRIER GAS He Rate 60 PSI ~~ml./min.~~
Pressures: Inlet Outlet
Hydrogen 40 PSI ~~ml./min.~~ Air 60 PSI ~~ml./min.~~
DETECTOR E.C. T.C. F.I.D. 4×10^{-11}
Scavenger Rate ml./min.
Sens. Rec.Range mv.
SAMPLE 1110 BULB-A Size 2.0 ml
Solvent Concn.

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6-19-81, Time 11:36:01, Instrument ID VARIAN 3700
Recorder/Printout Reference No. 31, Recorder ID HP3390A
Purpose of Run C_1-C_6 HYDROCARBON ANALYSIS
Sample Description 1115 BULB-B

GC CONDITIONS

Amount Injected 2.0ML, Inj. Port or Sample Loop Used 2.0ML LOOP
Detector Used: FID X, ECD __, FPD __, TCD __ (Current ____)
Detector Attenuation 4, Amplifier or Range 10^{-11}
Column: Liquid Phase ____, Solid Phase PORAPAK Q,
Length 6', O.D. 1/8", I.D. ____, Material S.S.
Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C
Temperature Program ISOTHERMAL

SAMPLE RUN

Sampling Method GRAB 500 ML S.S. BULB

RT	Area	Peak Height	Amount (ppm)	Component
.22	1220		1.1	C_1
.38	666			
.47	4480		1.8	C_2

Name of Operator M.D. CHIPS, Date 9-1 1981

```
LIST: ATT 2^ =  0

ATT 2^  -  2 0
LIST: ATT 2^ = -2
```

[illegible] sample 8 [illegible]
and [illegible]

[illegible] to

Operator M.B. Cain's Date 8-19-91
Column No. .... Length 6' Dia. 1/8"
Coating .... Conc. ....
Support PORAPAK Q Mesh 80/100
TEMP: Col: Init. 150 °C Final 150 °C
Rate .... °C/min. Det. 250 °C Inj. 150 °C
CARRIER GAS .... Rate 60 psi ml/min.
Pressures: Inlet .... Outlet ....
Hydrogen 30 psi ml/min. Air 60 psi ml/min.
DETECTOR E.C. .... T.C. .... F.I.D. 2 x 10^-11
Scavenger .... Rate .... ml/min.
Sens. .... Rec. Range .... mv.
SAMPLE #115 8-WB-13 Size 1.0 ml
Solvent .... Conc. ....

```
RUN #   73                AUG/19/91   11:36:01

ESTD
   RT              AREA  TYPE   CAL #         AMOUNT
  0.22             1238    PV     1            1.176
  0.33              316    VV    2R            0.230
  0.47             4408    VB                  0.000

TOTAL AREA=        5962
MUL FACTOR= 1.0000E+00
```

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 30 7602.91

Injection Date 6-19 81, Time 12:17:55, Instrument ID VARIAN 3700

Recorder/Printout Reference No. 32, Recorder ID HP3390A

Purpose of Run $C_1 - C_6$ HYDROCARBON ANALYSIS

Sample Description 1115 DRB-B

GC CONDITIONS

Amount Injected 2.0mL, Inj. Port or Sample Loop Used 2.0mL Loop

Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ___)

Detector Attenuation 4, Amplifier or Range 10^{-11}

Column: Liquid Phase ___, Solid Phase PORAPAK Q,

Length 6', O.D. 1/8", I.D. ___, Material S.S.

Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C

Temperature Program ISOTHERMAL

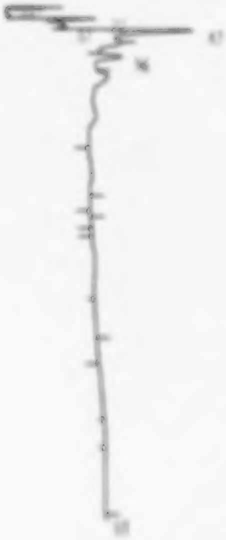
SAMPLE RUN

Sampling Method GRAB 500 ML S.S. BOMB

RT	Area	Peak Height	Amount (ppm)	Component
.23	1320		1.1	C_1
.37	480		1.6	C_2
.47	2754			
.96	445		0.1	C_3

Name of Operator M.D. CAIRS, Date 5-1 19 81

1115 Sample B Repeat
[illegible]



```
RUN #   32              JUN/13/91   12:17:35

ESTD
  RT          AREA TYPE  CAL#        AMOUNT
  0.22        12190  PV    1          1.170
  0.37         4169  VP   20          0.2164
  0.67         3754  PB               0.0000
  0.94         4471  BB               0.0000

TOTAL AREA=       [illegible]
MUL FACTOR= 1.0000E+00
```

Operator M. D. Crips Date 6-13-91
Column No. Length 6' Dia. 1/8"
Coating Concn.
Support PORAPAK Q Mesh 60/80
TEMP: Col: Init. 150 °C Final 150 °C
Rate °C/min. Det. 250 °C Inj. 180 °C
CARRIER GAS He Rate 60 PSI ml/min.
Pressures: Inlet Outlet
Hydrogen 40 PSI ~~ml/min.~~ Air 60 PSI ml/min.
DETECTOR E.C. T.C. F.I.D. 4 x 10⁻¹¹
Scavenger Rate ml/min.
Sens. Rec. Range mv
SAMPLE 1115 BULB-B Size 2.0 ml
Solvent Concn.

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6- -81, Time 14:26:42, Instrument ID VARIAN 3700

Recorder/Printout Reference No. 33, Recorder ID HP3390A

Purpose of Run C_1-C_6 HYDROCARBON ANALYSIS

Sample Description 1400 DULO-A

GC CONDITIONS

Amount Injected 2.0mL, Inj. Port or Sample Loop Used 2.0mL Loop

Detector Used: FID X, ECD __, FPD __, TCD __ (Current ____)

Detector Attenuation 4, Amplifier or Range 10^{-11}

Column: Liquid Phase ____, Solid Phase PORAPAK Q.

Length 6', O.D. 1/8", I.D. ____, Material S.S.

Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C

Temperature Program ISOTHERMAL

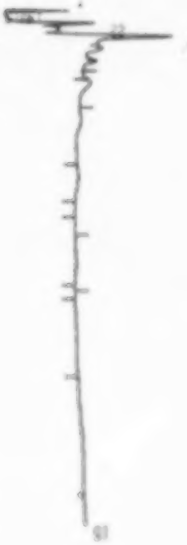
SAMPLE RUN

Sampling Method GRAB 500 mL S.S. BOLB

RT	Area	Peak Height	Amount (ppm)	Component
.82	1469		1.3	C_1
.96	5896		1.8	C_2

Name of Operator M.D. CAIRS, Date 9-1 19 81

1400 sampled taken 2?0°F
anal 2?0°F



Operator M.D. Schips Date 6-19-81
Column No. Length 6' Dia. 1/8"
Coating Concn.
Support PORAPAK Q Mesh 60/80
TEMP: Col: Init. 150 °C Final 150 °C
Rate °C/min. Det. 250 °C Inj. 120 °C
CARRIER GAS He Rate 60 psi ~~ml/min.~~
Pressures: Inlet Outlet
Hydrogen 40 psi ml./min. Air 60 psi ~~ml/min.~~
DETECTOR E.C. T.C. F.I.D. 4×10⁻¹¹
Scavenger Rate ml./min.
Sens. Rec.Range mv.
SAMPLE 1400 BULB-A Size 2.0 ml
Solvent Concn.

```
RUN #   33              JUN/13/91  14:26:42
NO CALIB PEAKS FOUND

AREA%
   RT          AREA TYPE   AR/HT       AREA%
  0.22         1409   PV   0.054      21.660
  0.41         5096   VV   0.112      78.340

TOTAL AREA=       6505
MUL FACTOR= 1.0000E+00
```

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6-19-81, Time 14:39:09, Instrument ID VARIAN 3700

Recorder/Printout Reference No. 34, Recorder ID HP3390A

Purpose of Run $C_1 - C_6$ HYDROCARBON ANALYSIS

Sample Description 1405 BULB-B

GC CONDITIONS

Amount Injected 2.0ML, Inj. Port or Sample Loop Used 2.0ML LOOP

Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ______)

Detector Attenuation 4, Amplifier or Range 10^{-11}

Column: Liquid Phase ______, Solid Phase PORAPAK Q,

Length 6', O.D. 1/8", I.D. ______, Material S.S.

Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C

Temperature Program ISOTHERMAL

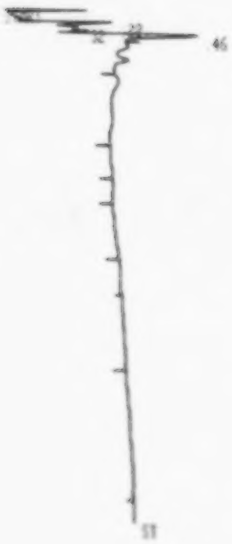
SAMPLE RUN

Sampling Method GRAB 500 ML S.S. BULB

RT	Area	Peak Height	Amount (ppm)	Component
.22	1101		1.0	C_1
.32	331	)		) C_2
.46	2729		1.1	

Name of Operator M.D. CAIRS, Date 9-1 19 81

1405 Sample B taken 108°F
Amb 78°F



Operator M.D. CHIPS Date 6-19-81
Column No. Length 6' Dia. 1/8"
Coating Concn.
Support PORAPAK Q Mesh 60/80
TEMP: Col: Init. 150 °C Final 150 °C
Rate °C/min. Det 250 °C Inj. 120 °C
CARRIER GAS He Rate 60 PSI ~~ml/min.~~
Pressures: Inlet Outlet
Hydrogen 40 PSI ~~ml/min.~~ Air 60 PSI ~~ml/min.~~
DETECTOR E.C. T.C. F.I.D. 4 X10⁻¹¹
Scavenger Rate ml/min.
Sens. Rec.Range mv.
SAMPLE 1405 BOL8-B Size 2.0 ml
Solvent Concn

```
RUN #  34                    JUN/19/81  14:39:09
NO CALIB PEAKS FOUND

AREA%
  RT           AREA TYPE   AR/HT       AREA%
  0.22         1101   PV   0.044      26.460
  0.32          331   VB   0.066       7.955
  0.46         2729   PB   0.070      65.585

TOTAL AREA=       4161
MUL FACTOR= 1.0000E+00
```

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 30760291

Injection Date 6-19-81, Time 1642:11, Instrument ID VARIAN 3700

Recorder/Printout Reference No. 2, Recorder ID HP3390A

Purpose of Run CALIBRATION

Sample Description SCOTT MULTI-COMPONENT MIXTURE CM-PARAFINS ±10%

GC CONDITIONS

Amount Injected 2.0 ML, Inj. Port or Sample Loop Used 2.0 ML LOOP

Detector Used: FID X, ECD __, FPD __, TCD __ (Current ____)

Detector Attenuation 4, Amplifier or Range 10^{-11}

Column: Liquid Phase ____, Solid Phase PORAPAK Q,

Length 6', O.D. 1/8", I.D. ____, Material S.S.

Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C

Temperature Program ISOTHERMAL

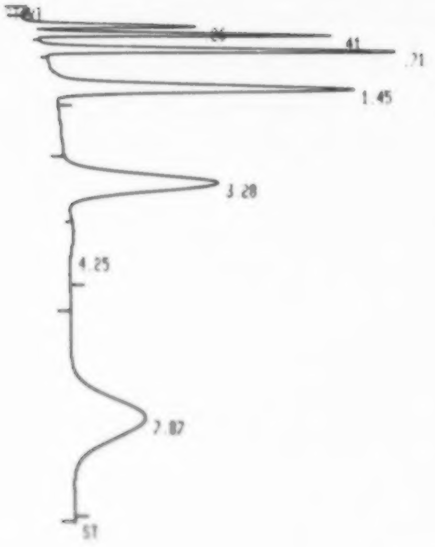
SAMPLE RUN

Sampling Method PURGE LOOP

RT	Area	Peak Height	Amount ppm	Component
.26	85310		17.0	C_1
.41	34372		10.3	C_2
.71	21631		10.6	C_3
1.45	14770		10.8	C_4
3.28	12880		10.4	C_5
7.87	11383		10.1	C_6

Name of Operator [illegible], Date 9-1 1981

$C_1 - C_6$ cal



Operator M. D. CHIPS Date 6-17-81
Column No. Length 6' Dia. 1/8"
Coating Concn.
Support PORAPAK Q Mesh 80/100
TEMP: Col: Init. 150 °C Final 150 °C
Rate °C/min. Det. 250 °C Inj. 120 °C
CARRIER GAS He Rate 60 PSI ~~ml/min.~~
Pressures: Inlet Outlet
Hydrogen 40 PSI ~~ml/min.~~ Air 60 PSI ~~ml/min.~~
DETECTOR E.C. T.C. F.I.D 4 x10⁻¹¹
Scavenger Rate ml/min.
Ser s. Rec. Range mv.
SAMPLE CAL #2 1624 Size 2.0 ml
Solvent Concn.

```
RUN #    2             JUN/19/81  16:42:11

AREA%
  RT          AREA TYPE    AR/HT      AREA%
  0.26       19034 D PV    0.405      5.488
  0.41       29949 D VV    0.075      8.635
  0.71       49004 D VV    0.056     14.130
  1.45       73116   VB    0.104     21.082
  3.28       80746   BV    0.400     23.292
  4.25        6241   VB    0.722      1.800
  7.07       88727   BB    0.930     25.583

TOTAL AREA=     346820
MUL FACTOR= 1.0000E+00
```

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6-19-81, Time 17:14:08, Instrument ID VARIAN 3700
Recorder/Printout Reference No. 3, Recorder ID HP3390
Purpose of Run C_1-C_6 HYDROCARBON ANALYSIS

Sample Description 1643 BULB-A

GC CONDITIONS

Amount Injected 2.0 ml, Inj. Port or Sample Loop Used 2.0 ml LOOP
Detector Used: FID X, ECD __, FPD __, TCD __ (Current ____)
Detector Attenuation 4, Amplifier or Range 10^{-11}
Column: Liquid Phase ____, Solid Phase PORAPAK Q,
Length 6', O.D. 1/8", I.D. ____, Material S.S.
Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C
Temperature Program ISOTHERMAL

SAMPLE RUN

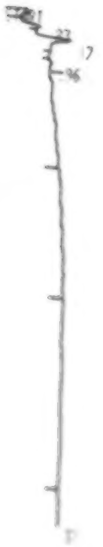
Sampling Method GRAB 500 ml S.S. BULB

RT	Area	Peak Height	Amount (ppm)	Component
.23	1649		1.5	C_1
.47	8656		2.0	C_2
.96	1610		0.2	C_4

Name of Operator M.D. CAIRNS, Date 9-1 1981

1645 SAMPLE A
30 PSI

SAMPLE
240°F
ANALYSIS
303°F



Operator M.D. CHIPS Date 6-19-81
Column No. Length 6' Dia. 1/8"
Coating Concn.
Support PORAPAK Q Mesh 60/80
TEMP: Col: Init. 150 °C Final 150 °C
Rate °C/min. Det. 250 °C Inj. 120 °C
CARRIER GAS He Rate 60 psi ~~ml/min.~~
Pressures: Inlet Outlet
Hydrogen 40 psi ~~ml/min.~~ Air 60 psi ~~ml/min.~~
DETECTOR E.C. T.C. F.I.D. 8×10⁻¹¹
Scavenger Rate ml/min.
Sens. Rec.Range mv.
SAMPLE 1643 BULB-A Size 2.0ML
Solvent Concn.

```
RUN 8
NO CALIB PEAKS FOUND          JUN/19/81   17:14:40

AREA%
  RT
  0.23        AREA TYPE   AR/HT        AREA%
  0.67        1649   PV   0.031       13.840
  0.96        8656   VV   0.169       72.648
              1610   VB   0.104       13.512

TOTAL AREA=       11915
MUL FACTOR 1.0000E+00
```

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6-19-81, Time 17:26:12, Instrument ID VARIAN 3700
Recorder/Printout Reference No. 4, Recorder ID HP3390
Purpose of Run C_1-C_6 HYDROCARBON ANALYSIS

Sample Description 1650 BULB-B

GC CONDITIONS

Amount Injected 2.0 ml, Inj. Port or Sample Loop Used 2.0 ml LOOP
Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ______)
Detector Attenuation 4, Amplifier or Range 10^{-11}
Column: Liquid Phase ______, Solid Phase PORAPAK Q,
Length 6', O.D. 1/8", I.D. ______, Material S.S.
Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C
Temperature Program ISOTHERMAL

SAMPLE RUN

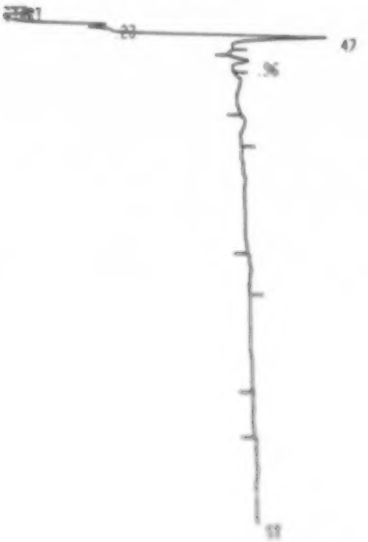
Sampling Method GRAB 500 ml S.S. BULB

RT	Area	Peak Height	Amount (ppm)	Component
.23	764		0.7	C_1
.49	8548		3.0	C_2
.96	613		0.09	C_4

Name of Operator M.D. CAIRS, Date 9/1 1981

1650 SampleB Sample 248°F
Anal 279°F

```
ATT 2^ -  2 0
LIST: ZERO =  0, 0.0
```



Operator M.D. CAIPS		Date 6-19-81	
Column No.	Length 6'	Dia. 1/8"	
Coating		Concn.	
Support PORAPAK Q		Mesh	
TEMP: Col: Init. 150 °C		Final 150 °C	
Rate °C/min.	Det. 250 °C	Inj. 120 °C	
CARRIER GAS He		Rate 60 PSI ~~ml/min.~~	
Pressures: Inlet		Outlet	
Hydrogen 40 PSI ~~ml/min.~~		Air 60 PSI ~~ml/min.~~	
DETECTOR E.C.	T.C.	F.I.D. 4 × 10⁻⁸	
Scavenger	Rate	ml/min.	
Sens.	Rec.Range	mv.	
SAMPLE 1650	BULB-B	Size 2.0 mL	
Solvent	Concn.		

```
RUN #    4                JUN/19/81  17:26:12
NO CALIB PEAKS FOUND

AREA%
   RT          AREA TYPE    AR/HT       AREA%
   0.23         764   PV    0.050       7.698
   0.47        8548   VB    0.144      86.126
   0.96         613   PB    0.106       6.176

TOTAL AREA=       9925
MUL FACTOR= 1.0000E+00
```

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client GMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6-9-81, Time 16:21:18, Instrument ID VARIAN 3700

Recorder/Printout Reference No. 1, Recorder ID HP3390A

Purpose of Run CALIBRATION

Sample Description SCOTT MULTI-COMPONENT MIXTURE (n-PARAFINS ±10%

GC CONDITIONS

Amount Injected 2.0 ml, Inj. Port or Sample Loop Used 2.0 ml Loop

Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ______)

Detector Attenuation 4, Amplifier or Range 10^{-11}

Column: Liquid Phase ______, Solid Phase PORAPAK Q,

Length 6', O.D. 1/8", I.D. ______, Material S.S.

Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C

Temperature Program ISOTHERMAL

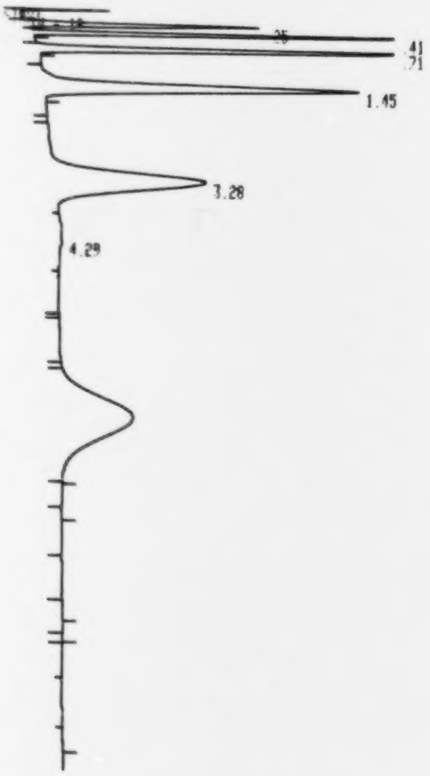
SAMPLE RUN

Sampling Method PURGE LOOP

RT	Area	Peak Height	Amount ppm	Component
.36	9.1123		17.0	C_1
.42	3.4823		10.3	C_2
.72	2.2887		10.6	C_3
1.46	1.6147		10.8	C_4
2.32	1.7578		10.4	C_5
3.88	1.1482		10.1	C_6

Name of Operator [illegible], Date 9-1 19 81

```
LIST: ZERO =  0, 0.0
```



```
STOP


RUN #    1                JUN/19/81  16:21:18

AREA%
  RT               AREA TYPE   AR/HT       AREA%
  0.25            18155   BV   0.059       7.462
  0.41            28629   VB   0.049      11.768
  0.71            44871   BB   0.071      18.444
  1.45            66644   PB   0.162      27.393
  3.28            79336   BV   0.394      32.610
  4.29             5653   VB   0.725       2.324

TOTAL AREA=     243290
MUL FACTOR= 1.0000E+00
```

Operator M.D. CHIPS Date 6-19-81
Column No. Length 6' Dia. 1/8"
Coating Concn.
Support PORAPAK Q Mesh 60/80
TEMP: Col: Init. 150 °C Final 150 °C
Rate °C/min. Det. 250 °C Inj. 120 °C
CARRIER GAS He Rate 60 PSI ~~ml/min.~~
Pressures: Inlet Outlet
Hydrogen 40 PSI ~~ml/min.~~ Air 60 PSI ~~ml/min.~~
DETECTOR E.C. T.C. F.I.D. 4×10^{-1}
Scavenger Rate ml./min.
Sens. Rec. Range mv.
SAMPLE CAL #1 1621 Size 2.0 ml
Solvent Concn.

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6-19-81, Time 18:19:32, Instrument ID VARIAN 3700

Recorder/Printout Reference No. 2, Recorder ID HP3390

Purpose of Run C_1-C_6 HYDROCARBON ANALYSIS

Sample Description BLANK BULB-B

GC CONDITIONS

Amount Injected 2.0 ml, Inj. Port or Sample Loop Used 2.0ml LOOP

Detector Used: FID X, ECD __, FPD __, TCD __ (Current ____)

Detector Attenuation 4, Amplifier or Range 10^{-11}

Column: Liquid Phase ____, Solid Phase PORAPAK Q,

Length 6', O.D. 1/8", I.D. ____, Material S.S.

Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C

Temperature Program ISOTHERMAL

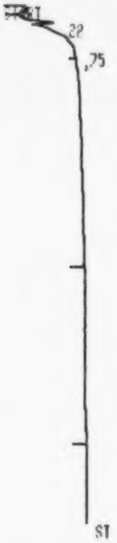
SAMPLE RUN

Sampling Method PURGE N_2

RT	Area	Peak Height	Amount (ppm)	Component
.22	1728		1.6	C_1
.75	6076		1.4	C_3

Name of Operator M.D. CHIPS, Date 9-1 1981

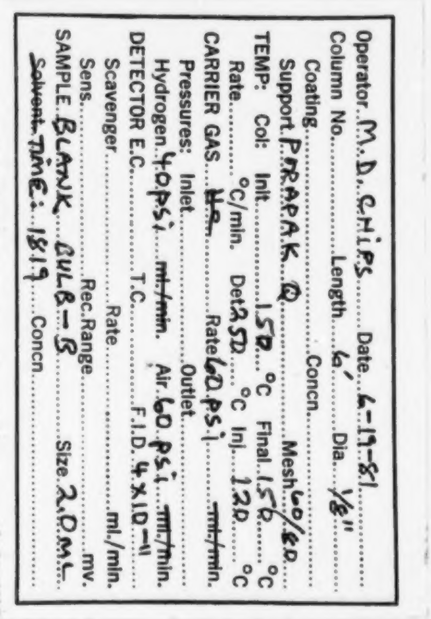
Blank Bulb B 60PSI
zero air
246°F



```
RUN #    2               JUN/19/81  18:19:32

ESTD
  RT            AREA TYPE  CAL#         AMOUNT
  0.22          1728  PV                 0.000
  0.75          6076  VB    3R           1.387

TOTAL AREA=       7804
MUL FACTOR= 1.0000E+00
```



Operator M.D. CHIPS Date 6-19-81
Column No. Length 6' Dia. 1/8"
Coating Concn.
Support PORAPAK Q Mesh 60/80
TEMP: Col: Init. 150 °C Final 150 °C
Rate °C/min. Det. 250 °C Inj. 120 °C
CARRIER GAS He Rate 60 psi ~~ml/min.~~
Pressures: Inlet Outlet
Hydrogen 40psi ~~ml/min.~~ Air 60 psi ~~ml/min.~~
DETECTOR E.C. T.C. F.I.D. 4 x 10⁻¹¹
Scavenger Rate ml/min.
Sens. Rec. Range mv.
SAMPLE BLANK BULB-B Size 2.0 ml
~~Solvent~~ TIME: 1819 Concn.

Reproduced from best available copy.

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client CMEA, Location TOSCO BAKERSFIELD, CA, Job No. 307602.91

Injection Date 6-19-81, Time 18:31:47, Instrument ID VARIAN 3700
Recorder/Printout Reference No. 3, Recorder ID HP3390
Purpose of Run C_1-C_6 HYDROCARBON ANALYSIS

Sample Description BLANK BULB-A

GC CONDITIONS

Amount Injected 2.0 ml, Inj. Port or Sample Loop Used 2.0ml LOOP
Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ______)
Detector Attenuation 4, Amplifier or Range 10^{-11}
Column: Liquid Phase ______, Solid Phase PORAPAK Q,
Length 6', O.D. 1/8", I.D. ______, Material S.S.
Temperature: Injector 120 °C, Oven 150 °C, Detector 250 °C
Temperature Program ISOTHERMAL

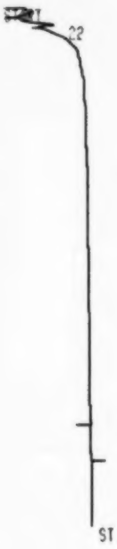
SAMPLE RUN

Sampling Method PURGE N_2

RT	Area	Peak Height	Amount (ppm)	Component
.22	1441		1.3	C_1

Name of Operator M.D. CHIPS, Date 9-1 1981

Bulb A Blank (repeat)



```
RUN #    3             JUN/19/81  18:31:47
NO CALIB PEAKS FOUND

AREA%
   RT         AREA TYPE   AR/HT      AREA%
  0.22        1441   PB   0.052    100.000

TOTAL AREA=       1441
MUL FACTOR= 1.0000E+00
```

Operator M.D. CHIPS Date 6-19-81
Column No. Length 6' Dia. 1/8"
Coating Concn.
Support PORAPAK Q Mesh 60/80
TEMP: Col: Init. 150 °C Final 150 °C
Rate °C/min. Det. 250 °C Inj. 120 °C
CARRIER GAS He Rate 60 psi ~~ml/min.~~
Pressures: Inlet Outlet
Hydrogen 40 PSI ~~ml/min.~~ Air 60 PSI ~~ml/min.~~
DETECTOR E.C. T.C. F.I.D. 4 x 10⁻¹¹
Scavenger Rate ml/min.
Sens. Rec.Range mv.
SAMPLE BLANK BULB-A Size 2.0
~~Solvent~~ TIME: 1831 Concn.

5.9 RADIOMETRIC ANALYSIS RESULTS

SAFETY SPECIALISTS, Inc.
3194 De La Cruz Blvd., Suite 15 • Santa Clara, California 95050 • Telephone (408) 988-1111

ASSAY REPORT

Acurex Corporation
485 Clyde Avenue
Attn: Ms. Linda Bohannon, M/S 0-1212
Mountain View, California 94042

Date: December 28, 1981

Date Samples Received: 11/11/81

Customer Order No. RB59185A, Rel. 20

		Activity*	
SSI No.	Client Description	Gross Beta pCi/Filter	Gross Gamma pCi/Filter
81388A	#1, A81-07-011-038, TOSCO 2 Filter	60.6 ± 7.8	≤ 143
B	#2, A81-07-011-545, TOSCO 1 Filter	75.0 ± 11.3	≤ 143
C	#3, A81-07-011-571, TOSCO Filter Blank	99.6 ± 13.6	≤ 142

SSI No.	Client Description	Gross Alpha pCi/liter
81388A	No. 1, A81-07-011-38, TOSCO 2 Filter	15 ± 12
B	No. 2, A81-07-011-545, TOSCO 1 Filter	≤ 18
C	No. 3, A81-07-011-571, TOSCO Filter Blank	≤ 19

Analyst: Fariba Danesh

Approved: T. C. Noble, Director
Safety & Health Services Division

*The ± values are the two sigma Poisson standard deviation of the counting error.
The ≤ values are equal to or less than three sigma of the counting error.

5.10 BIOASSAY REPORTS

GENETICS ASSAY NOS. 6153-6156
LBI SAFETY NOS. 7535-7538

MUTAGENICITY EVALUATION OF XAD RESIN EXTRACTS IN THE EPA LEVEL 1 AMES SALMONELLA/MICROSOME PLATE TEST

FINAL REPORT

SUBMITTED TO:

ACUREX CORPORATION
485 CLYDE AVENUE
MOUNTAIN VIEW, CALIFORNIA 94042

SUBMITTED BY:

LITTON BIONETICS, INC.
5516 NICHOLSON LANE
KENSINGTON, MARYLAND 20895

LBI PROJECT NO. 22064

REPORT DATE: MARCH 1982

PREFACE

This assay conforms to the standard EPA Level 1 procedure for the Ames *Salmonella*/microsome mutagenesis assay as described in "IERL-RTP Procedures Manual: Level 1 Environmental Assessment Biological Tests"[1]. The data were evaluated and formatted as recommended in "Level 1 Biological Testing Assessment and Data Formatting"[2].

The Ames *Salmonella*/microsome mutagenesis assay has been shown to be a sensitive method for detecting mutagenic activity for a variety of chemicals representing various chemical classes[3]. This assay is one of several recommended by EPA to identify, categorize and rank the pollutant potential of influent and effluent streams from industrial and energy-producing processes. This assay has been well validated with a wide range of positive and negative control chemicals and complex environmental samples.

All procedures and documents pertaining to the receipt, storage, preparation, testing and evaluation of the test material shall conform to Litton Bionetics, Inc. standard operating procedures, the U.S. Food and Drug Administration's Good Laboratory Practices Regulations of 1979[4] and the proposed U.S. Environmental Protection Agency's Good Laboratory Practice Guidelines[5,6]. Deviations from standard procedure shall be fully documented and noted in the report.

All test and control results in this report are supported by fully documented raw data which are permanently maintained in the files of the Department of Molecular Toxicology or in the archives of Litton Bionetics, Inc., 5516 Nicholson Lane, Kensington, Maryland 20895. Copies of raw data will be supplied to the sponsor upon request.

TABLE OF CONTENTS

Page No.

PREFACE i

I. SUMMARY 1

II. OBJECTIVE 2

III. TEST MATERIAL 3

- A. Description 3
- B. Handling and Preparation 3

IV. MATERIALS 5

- A. Indicator Microorganisms 5
- B. Media 6
- C. Activation System 6
  - 1. S9 Homogenate 6
  - 2. S9 Mix 6

V. EXPERIMENTAL DESIGN 7

- A. Dose Selection 7
- B. Mutagenicity Test 7
  - 1. Nonactivation Assay 7
  - 2. Activation Assay 8
- C. Control Compounds 8
- D. Recording and Presenting Data 10

VI. RESULTS 11

- A. Interpretations 11
  - 1. TOSCO 2 XAD + OMC 11
  - 2. TOSCO 1 XAD 12
  - 3. MOHAWK 1 XAD 12
  - 4. MOHAWK 2 XAD 13
- B. Tables 14

VII. ASSAY ACCEPTANCE AND EVALUATION CRITERIA 27

- A. Surviving Populations 27
- B. Dose-Response Phenomena 28
- C. Control Tests 28
- D. Evaluation Criteria for Ames Assay 28
  - 1. Strains TA-1535 and TA-1537 29
  - 2. Strains TA-98 and TA-100 29
  - 3. Pattern 29
  - 4. Reproducibility 29
- E. Relation Between Mutagenicity and Carcinogenicity 30
- F. Criteria for Ranking Samples in the Ames Assay . . 30

VIII. REFERENCES 32

I. SUMMARY

Four resin extract samples supplied by Acurex Corporation were tested and evaluated for their mutagenic activities in the EPA Level 1 Ames Salmonella/microsome mutagenesis assay. The samples, supplied in methylene chloride, were solvent exchanged to 2.0 ml of dimethylsulfoxide (DMSO) prior to testing. The samples were identified as TOSCO 2 XAD + OMC (A81-07-011-562,559), TOSCO 1 XAD (A81-07-011-569), MOHAWK 1 XAD (A81-09-007-488) and MOHAWK 2 XAD (A81-09-007-495).

In order to preserve the maximum quantity of test material, it was decided to test each sample in only two strains, TA-98 and TA-100 using a single plate per dose. Tests were conducted in duplicate both with and without S9 metabolic activation mix. Even with these modifications, it was impossible to reach the Maximum Applicable Dose (MAD) for the Ames assay which is 5000 µg/plate. In the Mohawk [illegible] XAD sample no activity was observed in the highest dose, but based on the limited organic content, a Non Detectable classification could not be assigned. The sample was ranked as having undetermined mutagenicity, but moderate or less. The TOSCO 2 XAD sample was the most mutagenic with a Minimum Effective Concentration (MEC) of 30 µg/plate, placing the sample in the high mutagenicity category. Mohawk 1 XAD and TOSCO 1 XAD, were the next most active samples with MEC values of 75 µg/plate (moderate mutagenicity) and 85 µg/plate (moderate mutagenicity), respectively.

Insufficient quantities of test material prevented standard Level 1 Ames testing of the four samples. While three of the samples were found to be mutagenic and were ranked by EPA Level 1 evaluation criteria the MEC of those samples should be viewed with some caution. Adequate retesting was not possible to confirm the accuracy of the reported MEC values.

Submitted by:

Cynthia Rabenold 4/7/82
Cynthia Rabenold, B.S. Date
Submammalian Genetics,
Department of Molecular
Toxicology

Reviewed by:
Study Director

4/7/82
David J. Brusick, Ph.D. Date
Director,
Department of Molecular
Toxicology

II. OBJECTIVE

The objective of this study was to determine and rank the genetic activity of four XAD resin extract samples in the EPA Level 1 Ames *Salmonella* mutagenesis assay with and without the addition of mammalian metabolic activation preparations. The samples were solvent exchanged into dimethylsulfoxide (DMSO) before Ames testing was initiated. The genetic activity of each sample was measured in these assays by its ability to revert the *Salmonella* indicator strains from histidine dependence to histidine independence. The degree of genetic activity of a sample was reflected in the number of revertants that were observed on the histidine-free medium. Standard EPA Level 1 mutagenicity evaluation criteria for the Ames mutagenesis assay were used to rank the mutagenic potential of each test material.

III. TEST MATERIAL

A. Description

Four samples were supplied by Acurex Corporation, Mountain View, California. The samples were assigned LBI safety numbers and LBI assay numbers upon receipt. The Acurex code numbers, sample identification, LBI safety numbers and LBI assay numbers are identified below. All laboratory documentation used the LBI assay number to identify samples.

The four test materials were received as clear, yellow solutions of organic material in methylene chloride except for the TOSCO 1 XAD sample. That sample was an amber-colored, clear solution with a few suspended particles. The quantity of organic material in each sample, as determined by Acurex Corporation, is identified below. No information on sampling parameters (such as the equivalent volume of stack gas represented by the sample) was provided.

Acurex Corp. Code	Sample Identification	Quantity (mg organic)	LBI Safety No.	LBI Assay No.
A81-07-011-562, 559	TOSCO 2 XAD + OMC	12	7537	6153
A81-07-011-569	TOSCO 1 XAD	17	7538	6154
A81-09-007-488	MOHAWK 1 XAD	6	7535	6155
A81-09-007-495	MOHAWK 2 XAD	4	7536	6156

B. Handling and Preparation

The test materials were received at LBI on February 8, 1982. The samples were shipped in small, clear-glass vials sealed with crimp-top aluminum caps with rubber liners. The samples were received intact and were stored at +4°C in the dark until processed.

Pretest sample preparation consisted of solvent exchanging the samples into dimethysulfoxide (DMSO). The samples were transferred with methylene chloride rinses into graduated conical tubes. The methyl chloride was gradually evaporated (50°C under a stream of nitrogen) and DMSO was sequentially added. The samples were brought to volume in 2.0 ml of DMSO. The samples were transferred to glass vials and sealed with teflon-coated rubber rounds. The solvent exchanged samples were stored at +4°C in the dark.

IV. MATERIALS

A. Indicator Microorganisms

The Salmonella typhimurium strains used in this assay were obtained from Dr. Bruce Ames, University of California at Berkeley[7-12]. The following four strains were used.

Strain Designation	Gene Affected	Additional Mutations			Mutation Type Detected
		Repair	LPS	R Factor	
TA-1535	his G	Δ uvr B	rfa	-	Base-pair substitution
TA-1537	his C	Δ uvr B	rfa	-	Frameshift
TA-98	his D	Δ uvr B	rfa	pKM101	Frameshift
TA-100	his G	Δ uvr B	rfa	pKM101	Base-pair substitution

All the above strains have, in addition to the mutation in the histidine operon, mutation (rfa-) that leads to defective lipopolysaccharide coat, a deletion that covers genes involved in the synthesis of vitamin biotin (bio-) and in the repair of ultraviolet (uv) - induced DNA damage (uvrB-). The rfa- mutation makes the strains more permeable to many large molecules. The uvrB- mutation decreases repair of some types of chemically or physically damaged DNA and thereby enhances the strain's sensitivity to some mutagenic agents. The resistant transfer factor plasmid (R factor) pKM101 in TA-98 and TA-100 is believed to cause an increase in error-prone DNA repair that leads to many more mutations for a given dose of most mutagens[11]. In addition, plasmid pKM101 confers resistance to the antibiotic ampicillin, which is a convenient marker to detect the presence of plasmid in the cells.

All indicator strains were kept at 4°C on minimal medium plates supplemented with a trace of biotin and an excess of histidine. In addition, the plates with plasmid-carrying strains contained ampicillin (25 μg/ml) to ensure stable maintenance of plasmid pKM101. New stock culture plates were made as often as necessary from the frozen master cultures or from single colony reisolates that were checked for their genotypic characteristics (*his*, *rfa*, *uvrB*, and *bio*) and for the presence of plasmid. For each experiment, an inoculum from the stock culture plates was grown overnight at 37°C in nutrient broth (Oxoid CM67) and used.

B. Media

The bacterial strains were cultured in Oxoid Media #2 (Nutrient Broth). The selective medium was Vogen Bonner Medium E with 2 percent glucose[13]. The overlay agar consisted of 0.6 percent purified agar with 0.05 mM histidine, 0.05 mM biotin and 0.1M NaCl according to the methods of Ames *et al*[12].

C. Activation System

1. S9 Homogenate

A 9,000 x *g* supernatant prepared from Sprague-Dawley adult male rat liver induced by Aroclor 1254 (Ames *et al.*[12]) was purchased commercially and used in these assays.

2. S9 Mix

S9 mix used in these assays consisted of the following components:

Components	Concentration per Milliliter S9 Mix
NADP (sodium salt)	4 µmoles
D-glucose-6-phosphate	5 µmoles
$MgCl_2$	8 µmoles
KCl	33 µmoles
Sodium phosphate buffer pH 7.4	100 µmoles
Organ homogenate from rat liver (S9 fraction)	100 µliters

V. EXPERIMENTAL DESIGN

A. Dosage Selection

Test strategy and dose selection depend upon sample type and sample availability. The Level 1 manual[1] recommends solids to be initially tested at the maximum applicable dose (MAD) of 5 mg per plate and at lower concentrations of 2.5, 1, 0.5, 0.1 and 0.05 mg per plate. Liquids are tested initially at the MAD of 200 µl per plate, and at lower concentrations of 100, 50 and 10 µl per plate. Samples are retested over a narrower range of concentrations with strains showing positive results initially. Alternate doses are employed if sample size is limiting or at the direction of the sponsor.

Because sample size was limiting, a preliminary test was performed with strain TA-98, both with and without S9 metabolic activation, at 10 µl per plate for each sample. Doses selected for the second trial with each sample were either 1, 5, 10 and 50 µl per plate for TOSCO 2 XAD + OMC or 1, 10, 25 and 50 µl per plate for the other three samples. The third trial used 50 µl per plate and, in some cases, also included 25 and 75 µl per plate.

B. Mutagenicity Testing

The procedure used was based on the paper published by Ames _et_. _al_.[12] and was performed as follows:

1. Nonactivation Assay

To a sterile 13 x 100 mm test tube placed in a 43°C water bath the following was added in order:

- 2.00 ml of 0.6 percent agar containing 0.05 mM histidine and 0.05 mM biotin.
- Aliquot of test sample to give the appropriate dose.

- 0.1 ml to 0.2 ml of indicator organism(s).

- 0.50 ml of 0.2M phosphate buffer, pH 7.4.

This mixture was swirled gently and then poured onto minimal agar plates (see IV B, Media). After the top agar had set, the plates were incubated at 37°C for approximately 2 days. The number of his+ revertant colonies growing on the plates were counted with an automatic colony counter and recorded.

2. Activation Assay

The activation assay was run concurrently with the nonactivation assay. The only difference was the addition of 0.5 ml of S9 mix (see IV C, Activation System) to the tubes in place of 0.5 ml of phosphate buffer which was added in nonactivation assays. All other details were similar to the procedure for nonactivation assays.

A detailed flow diagram for the plate incorporation assay is provided in Figure 1.

C. Control Compounds

A negative control consisting of the solvent used for the test material was also assayed concurrently with the test material. For negative controls, step 'b' of Nonactivation Assays was replaced by 0.05 ml of the solvent. The negative controls were employed for each indicator strain and were performed in the absence and presence of S9 mix. The solvent used to prepare the stock solution of the test material is given in the Results section of this report. All dilutions of the test material were made using this solvent. The amount of solvent used was equal to the maximum volume used to give the appropriate test dose.

AMES ASSAY [PLATE INCORPORATION METHOD]

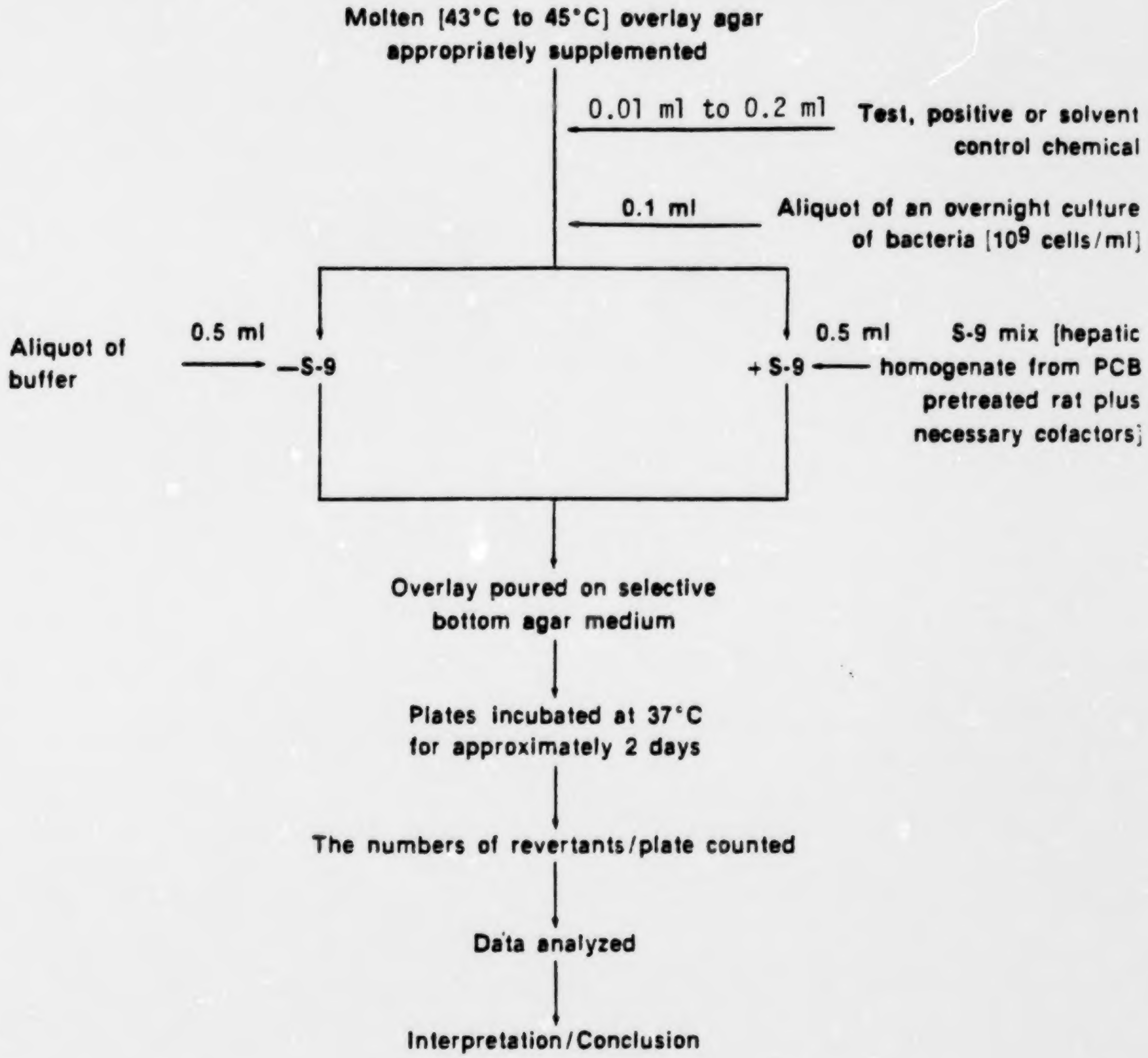

Molten [43°C to 45°C] overlay agar appropriately supplemented
0.01 ml to 0.2 ml
Test, positive or solvent control chemical
0.1 ml
Aliquot of an overnight culture of bacteria [10^9 cells/ml]
Aliquot of buffer
0.5 ml
—S-9
+S-9
0.5 ml
S-9 mix [hepatic homogenate from PCB pretreated rat plus necessary cofactors]
Overlay poured on selective bottom agar medium
Plates incubated at 37°C for approximately 2 days
The numbers of revertants/plate counted
Data analyzed
Interpretation/Conclusion

Figure 1 AMES SALMONELLA/MICROSOME MUTAGENESIS ASSAY

Specific positive control compounds known to revert each strain were also used and assayed concurrently with the test material. The concentrations and specificities of these compounds to specific strains are given in the following table:

Assay	Chemical	Solvent	Concentration per plate (μg)	Salmonella Strains
Nonactivation	Sodium azide	Water	10.0	TA-1535, TA-100
	2-Nitrofluorene (NF)	Dimethyl-sulfoxide	10.0	TA-98
	9-aminoacridine (9AA)	Ethanol	50.0	TA-1537
Activation	2-anthramine (ANTH)	Dimethyl-sulfoxide	2.5	For all strains

D. Recording and Presenting Data

The number of colonies on each plate were counted and recorded on printed forms. These raw data were analyzed in a computer program and reported on a printout. The results are presented as revertants per plate for each indicator strain employed in the assay. The positive and solvent controls are provided as reference points.

VI. RESULTS

A. Interpretation

With the limited amount of each sample received, the size of each Ames test was reduced to two strains, TA-98 and TA-100. A preliminary range-finding trial was performed with each sample (Trial 1 for each sample) using the single dose of 10 µl/plate in strain TA-98. The results from this single data point were used to select an appropriate dose range for testing. This modified test strategy helped somewhat to conserve limited test material. Even with this step, the amount of sample was not sufficient to produce reproducible MEC value. The MEC values calculated for this study used the best data available from each series of tests.

The results of the assays showed that three of the four samples were mutagenic in either one strain or both. The most mutagenic sample on a per-weight basis was TOSCO 2 XAD (MEC of 30 µg/plate) followed by Mohawk 1 XAD (MEC of 75 µg/plate) and TOSCO 1 XAD (MEC of 85 µg/plate). Mohawk 2 XAD was not mutagenic under the test conditions employed up to a level of 100 µg organics per plate.

1. TOSCO 2 XAD + OMC

The primary stock of the sample was prepared at 6 µg organics per µl DMSO. The test material was evaluated in Salmonella strains TA-98 and TA-100 both with and without S9 metabolic activation mix. The dose range used in Trial 2 was 1, 5, 10 and 50 µl per plate. The test sample was positive in TA-98 and marginally positive in TA-100 and appeared to be slightly more active without S9 mix. The sample was retested (Trial 3) at 50 µl and 75 µl (TA-100 only) per plate to verify the positive effect and because the TA-98 spontaneous background in Trial 2 was higher than assay acceptance criteria permit (see Section VII.B.).

The minimum effective concentration (MEC) based on this data was 5 μl (30 μg organics) per plate with strain TA-98 without S9 metabolic activation. The sample showed a dose response over the range of concentrations tested in Trial 2. Based upon the EPA Level 1 evaluation criteria, the sample was ranked as having high (H) mutagenic activity.

2. TOSCO 1 XAD

The primary stock of the sample was prepared at 8.5 μg organics per ml of DMSO. The initial trial at 10 μl per plate with TA-98 was positive, both with and without S9 metabolic activation. The test material was then evaluated in Salmonella strains TA-98 and TA-100 both with and without S9 metabolic activation mix. The dose range used in Trial 2 was 5, 10, 25 and 50 μl per plate. The test sample was not mutagenic for TA-98 in Trial 2, but showed a positive effect in Trial 3 at 50 μl per plate. The reason for this was attributed to the high spontaneous mutant background with TA-98 in Trial 2.

The test sample was weakly mutagenic for TA-100 in Trial 2 showing a dose-related increase in the number of revertants, but never quite reaching the threshold for a positive response. The Trial 3 TA-100 results were positive with activation 50 and 75 μl per plate. The minimum effective concentration was selected from Trial 1 for TA-98 (MEC of 10 μl per plate; 85 μg organics) TOSCO 1 XAD was found to have moderate mutagenic activity, but at a level closely approaching the high mutagenicity category. The sample was ranked as having moderate (M) mutagenicity based upon the EPA Level 1 evaluation criteria. Had sufficient sample been available for adequate testing, a clearer picture of the potency could have been obtained.

3. MOHAWK 1 XAD

The test material was prepared at a stock concentration of 3 μg organics per ml DMSO. The test material was evaluated in Salmonella strains TA-98 and TA-100 both with and without S9 mix. The initial range-finding trial with TA-98 at 10 μl per plate was negative. The dose range used in Trial 2 was 5, 10, 25 and 50 μl per plate. The material was positive for both TA-98 and TA-100 although the solvent control values for TA-98 were higher than normal. Activity in the presence of S9 mix was greater than without S9 mix. This suggests the presence of promutagens in the mixture. Strain TA-98 exhibited a dose-related increase in the number of revertants both with and without metabolic activation. Trial 3 was conducted to confirm Trial 2 and because the TA-98 spontaneous values from Trial 2 were higher than assay acceptance criteria permit.

The minimum effective concentration (MEC) based on this data was 25 μl (75 μg organics) per plate with both TA-98 and TA-100 in the presence of S9 mix (Trial 2 and Trial 3). Therefore, the Mohawk 1 XAD sample was ranked as having moderate (M) mutagenic activity based upon the EPA Level 1 evaluation criteria. The MEC of 75 μg per plate closely approaches the moderate/high borderline of 50 μg per plate. Had sufficient test material been supplied to adequately test the sample, the MEC could have been determined with greater precision.

4. MOHAWK 2 XAD

Only 4 mg of test material was supplied for both Ames and CHO testing. The sample was prepared in 2 ml DMSO giving a primary stock concentration of 2 μg organics per μl. The initial range-finding trial was conducted with TA-98 with and without S9 mix at 10 μl per plate. The nonactivation trial was negative, while the activation trial just reached the threshold for a positive response. The test material was then evaluated in Salmonella strains TA-98 and TA-100 both with and without S9 mix. The dose range used in Trial 2 was 5, 10, 25 and 50 μl per plate. Both strains appeared to be negative and no dose-related increase in mutant levels was noted. The TA-98 solvent controls in Trial 2 were higher than assay acceptance criteria permit. Trial 3 was conducted at 50 μl per plate to confirm Trial 2 responses and because of the elevated TA-98 spontaneous mutant background level.

This test material was not mutagenic in either strains TA-98 or TA-100 under test conditions with and without S9 mix. No MEC could be detected under the test conditions employed. The very weakly positive result with strain TA-98 with activation at 10 µl per plate (Trial 1) was considered to be an anomaly because it was not reproducable and because no dose response was observed. Additional testing at higher concentrations was impossible because of the lack of sufficient test material. Since the sample could not be tested up to the maximum applicable dose (MAD) of 5000 µg per plate and none of the doses tested were mutagenic, the test material could not be evaluated. The MEC, if the sample is mutagenic, was found to be greater than 100 µg per plate. The mutagenicity of the sample was interpreted as being undetermined, but moderate or less.

B. Tables

This report is based on the data provided in Tables 1 through 12.

```
 RESULTS                                          TABLE 1
-----------------------------------

A.    NAME OR CODE DESIGNATION OF THE TEST COMPOUND:  TOSCO  2 XAD+OMC (A81-07-011-562,559)
B.    SOLVENT:  NONE
C.    TEST INITIATION DATES:  03/05/82
D.    TEST COMPLETION DATE: 03/08/82
F.    S-9 LOT#: REK085
NOTE:   CONCENTRATIONS ARE GIVEN IN MICROLITERS   PER  PLATE
                                       R E V E R T A N T S   P E R   P L A T E
                                      ---------------------------------------------------------------------
TEST                SPECIES TISSUE   TA-98
----                ------- ------   ---------------
                                       1    2    3
NONACTIVATION
-------------

 NEGATIVE CONTROL      ---     ---     67
 NEGATIVE CONTROL      ---     ---     69
 POSITIVE CONTROL**    ---     ---    948
 POSITIVE CONTROL**    ---     ---    971
 TEST COMPOUND
      10.00     UL     ---     ---     31

ACTIVATION
----------

NEGATIVE CONTROL       RAT    LIVER    72
NEGATIVE CONTROL       RAT    LIVER    61
 POSITIVE CONTROL***   RAT    LIVER  1921
 POSITIVE CONTROL***   RAT    LIVER   856
 TEST COMPOUND
      10.00     UL     RAT    LIVER     0
-------------------------------------------------------------------------------------------------------

**                                                               ***
   TA-98    2-NITROFLUORENE                   10 UG/PLATE          TA-98    2-ANTHRAMINE  2.5 UG/PLATE
 RESULTS                                              TABLE 2
---------------------------------

A.    NAME OR CODE DESIGNATION OF THE TEST COMPOUND:  TOSCO 2 XAD+OMC (A81-07-011-562,559)
B.    SOLVENT:  CONE
C.    TEST INITIATION DATES:  03/15/82
D.    TEST COMPLETION DATE: 03/18/82
E.    S-9 LOT#: RFK 085
NOTE:   CONCENTRATIONS ARE GIVEN IN MICROLITERS   PER  PLATE

                                  R E V E R T A N T S   P E R   P L A T E
                                 ---------------------------------------------------------------------------
TEST                 SPECIES TISSUE  TA-98            TA-100
----                 ------- ------ --------------- ---------------
                                      1    2    3     1    2    3
NONACTIVATION
-------------

SOLVENT CONTROL      ---     ---     104             175
SOLVENT CONTROL      ---     ---     105             174
POSITIVE CONTROL**   ---     ---     508            1121
POSITIVE CONTROL**   ---     ---     565            1217
TEST COMPOUND
      1.00     UL    ---     ---     152             203
      5.00     UL    ---     ---     226             218
     10.00     UL    ---     ---     300             235
     50.00     UL    ---     ---     553             307

ACTIVATION
----------

SOLVENT CONTROL       RAT     LIVER   97             138
SOLVENT CONTROL       RAT     LIVER  101             146
POSITIVE CONTROL***   RAT     LIVER 2245             552
POSITIVE CONTROL***   RAT     LIVER 2286            1051
TEST COMPOUND
      1.00     UL     RAT     LIVER  132             152
      5.00     UL     RAT     LIVER  144             150
     10.00     UL     RAT     LIVER  199             147
     50.00     UL     RAT     LIVER  401             261
-----------------------------------------------------------------------------------------------------

**                                                                ***
   TA-98    2-NITROFLUORENE                      10 UG/PLATE        TA-98     2-ANTHRAMINE  2.5 UG/PLATE
   TA-100   SODIUM AZIDE                         10 UG/PLATE        TA-100    2-ANTHRAMINE  2.5 UG/PLATE
   SOLVENT  50 UL/PLATE
```

Reproduced from
best available copy.

```
 RESULTS                                                    TABLE 3
--------------------------------

A.    NAME OR CODE DESIGNATION OF THE TEST COMPOUND:  TOSCO 2 XAD+OMC(A81-07-011-562,559)
B.    SOLVENT:  NONE
C.    TEST INITIATION DATE:  03/19/82
D.    TEST COMPLETION DATE: 03/22/82
F.    S-9 LOT#: REK085
NOTE:   CONCENTRATIONS ARE GIVEN IN MICROLITERS   PER  PLATE

                                        R E V E R T A N T S   P E R   P L A T E
                                       ---------------------------------------------------------------------
TEST               SPECIES TISSUE   TA-98           TA-100
----               ------- ------ --------------- ---------------
                                        1    2    3    1    2    3
NONACTIVATION
-------------

SOLVENT CONTROL       ---     ---     27              101
SOLVENT CONTROL       ---     ---     20               97
POSITIVE CONTROL**    ---     ---    853             1328
POSITIVE CONTROL**    ---     ---    848             1367
TEST COMPOUND
     50.00      UL    ---     ---    282              150
     75.00      UL    ---     ---      -              427

ACTIVATION
----------

SOLVENT CONTROL       RAT    LIVER   27               96
SOLVENT CONTROL       RAT    LIVER   29              113
POSITIVE CONTROL***   RAT    LIVER 1551             2337
POSITIVE CONTROL***   RAT    LIVER 1661             2393
TEST COMPOUND
     50.00      UL    RAT    LIVER  251              206
     75.00      UL    RAT    LIVER    -              384
-----------------------------------------------------------------------------------------------------------

**                                                                    ***
   TA-98    2-NITROFLUORENE                          10 UG/PLATE          TA-98    2-ANTHRAMINE  2.5 UG/PLATE
   TA-100   SODIUM AZIDE                             10 UG/PLATE          TA-100   2-ANTHRAMINE  2.5 UG/PLATE
   SOLVENT  75 UL/PLATE
 - INDICATES TEST WAS NOT DONE
```

```
  RESULTS                                            TABLE 4
--------------------------------

A.    NAME OR CODE DESIGNATION OF THE TEST COMPOUND:  TOSCO 1 XAD (A81-07-011-569)
B.    SOLVENT:  NONE
C.    TEST INITIATION DATES:  03/05/82
D.    TEST COMPLETION DATE: 03/08/82
F.    S-9 LOT#: RFK085
NOTE:   CONCENTRATIONS ARE GIVEN IN MICROLITERS   PER  PLATE

                                        R E V E R T A N T S   P E R   P L A T E
                                      ------------------------------------------------------------------
TEST                 SPECIES TISSUE   TA-98
----                 ------- ------ ---------------
                                         1    2    3
NONACTIVATION
-------------

NEGATIVE CONTROL        ---     ---     67
NEGATIVE CONTROL        ---     ---     69
POSITIVE CONTROL**  ---     ---    948
POSITIVE CONTROL**  ---     ---    971
TEST COMPOUND
      10.00     UL   ---     ---    141

ACTIVATION
----------

NEGATIVE CONTROL        RAT     LIVER   72
NEGATIVE CONTROL        RAT     LIVER   61
POSITIVE CONTROL***  RAT     LIVER 1921
POSITIVE CONTROL***  RAT     LIVER  856
TEST COMPOUND
      10.00     UL   RAT     LIVER  165
------------------------------------------------------------------------------------------------------

**                                                              ***
   TA-98    2-NITROFLUORENE                 10 UG/PLATE            TA-98    2-ANTHRAMINE  2.5 UG/PLATE
```

RESULTS

TABLE 5

A. NAME OR CODE DESIGNATION OF THE TEST COMPOUND: TOSCO 1 XAD (A81-07-011-569)
B. SOLVENT: NONE
C. TEST INITIATION DATES: 03/15/82
D. TEST COMPLETION DATE: 03/18/82
E. S-9 LOT#: REK085
NOTE: CONCENTRATIONS ARE GIVEN IN MICROLITERS PER PLATE

TEST		SPECIES	TISSUE	REVERTANTS PER PLATE					
				TA-98			TA-100		
				1	2	3	1	2	3
NONACTIVATION									
SOLVENT CONTROL		---	---	104			175		
SOLVENT CONTROL		---	---	105			174		
POSITIVE CONTROL**		---	---	508			1121		
POSITIVE CONTROL**		---	---	565			1217		
TEST COMPOUND									
5.00	UL	---	---	65			190		
10.00	UL	---	---	106			204		
25.00	UL	---	---	112			232		
50.00	UL	---	---	94			290		
ACTIVATION									
SOLVENT CONTROL		RAT	LIVER	97			138		
SOLVENT CONTROL		RAT	LIVER	101			146		
POSITIVE CONTROL***		RAT	LIVER	2245			992		
POSITIVE CONTROL***		RAT	LIVER	2286			1051		
TEST COMPOUND									
5.00	UL	RAT	LIVER	107			194		
10.00	UL	RAT	LIVER	97			196		
25.00	UL	RAT	LIVER	114			211		
50.00	UL	RAT	LIVER	102			192		

**
TA-98 2-NITROFLUORENE 10 UG/PLATE
TA-100 SODIUM AZIDE 10 UG/PLATE
SOLVENT 50 UL/PLATE

***
TA-98 2-ANTHRAMINE 2.5 UG/PLATE
TA-100 2-ANTHRAMINE 2.5 UG/PLATE

Reproduced from best available copy.

RESULTS

TABLE 6

A. NAME OR CODE DESIGNATION OF THE TEST COMPOUND: TOSCO 1 XAD (A81-07-011-569)
B. SOLVENT: NONE
C. TEST INITIATION DATES: 03/19/82
D. TEST COMPLETION DATE: 03/22/82
E. S-9 LOT#: REK085
NOTE: CONCENTRATIONS ARE GIVEN IN MICROLITERS PER PLATE

TEST	SPECIES	TISSUE	REVERTANTS PER PLATE					
			TA-98			TA-100		
			1	2	3	1	2	3
NONACTIVATION								
SOLVENT CONTROL	---	---	27			101		
SOLVENT CONTROL	---	---	28			97		
POSITIVE CONTROL**	---	---	853			1367		
POSITIVE CONTROL**	---	---	848			1328		
TEST COMPOUND								
50.00 UL	---	---	136			154		
ACTIVATION								
SOLVENT CONTROL	RAT	LIVER	27			56		
SOLVENT CONTROL	RAT	LIVER	29			113		
POSITIVE CONTROL***	RAT	LIVER	1551			2337		
POSITIVE CONTROL***	RAT	LIVER	1661			2393		
TEST COMPOUND								
50.00 UL	RAT	LIVER	199			232		
75.00 UL	RAT	LIVER	-			323		

**
TA-98 2-NITROFLUORENE 10 UG/PLATE
TA-100 SODIUM AZIDE 10 UG/PLATE
SOLVENT 75 UL/PLATE
- INDICATES TEST WAS NOT DONE

***
TA-98 2-ANTHRAMINE 2.5 UG/PLATE
TA-100 2-ANTHRAMINE 2.5 UG/PLATE

```
  RESULTS
 ----------------------------------                      TABLE 7

 A.    NAME OR CODE DESIGNATION OF THE TEST COMPOUND:  MOHAWK1XAD (A81-09-007-488)
 B.    SOLVENT:  NONE
 C.    TEST INITIATION DATES:  03/05/82
 D.    TEST COMPLETION DATE: 03/08/82
 F.    S-9 LOT#: RFK085
 NOTE:   CONCENTRATIONS ARE GIVEN IN MICROLITERS   PER  PLATE

                                     R E V E R T A N T S   P E R   P L A T E
 TEST                 SPECIES TISSUE  TA-98
 ----                 ------- ------ ---------------------------------------------------------------------------
                                     ----------------
 NONACTIVATION                          1     2     3
 -------------

  NEGATIVE CONTROL      ---     ---     57
  NEGATIVE CONTROL      ---     ---     69
 POSITIVE CONTROL**     ---     ---    948
 POSITIVE CONTROL**     ---     ---    971
 TEST COMPOUND
      10.00      UL     ---     ---    110
 ACTIVATION
 ----------

 NEGATIVE CONTROL        RAT    LIVER   72
 NEGATIVE CONTROL        RAT    LIVER   61
 POSITIVE CONTROL***     RAT    LIVER 1921
 POSITIVE CONTROL***     RAT    LIVER  856
 TEST COMPOUND
      10.00      UL      RAT    LIVER   88
 ---------------------------------------------------------------------------------------------------------------

 **
   TA-98    2-NITROFLUORENE                          10 UG/PLATE        ***
                                                                           TA-98    2-ANTHRAMINE  2.5 UG/PLATE
```

Reproduced from
best available copy.

RESULTS

TABLE 9

A. NAME OR CODE DESIGNATION OF THE TEST COMPOUND: MOHAWK1 XAD (A81-09-007-488)
B. SOLVENT: NONE
C. TEST INITIATION DATES: 03/15/82
D. TEST COMPLETION DATE: 03/18/82
E. S-9 LOT#: REK085
NOTE: CONCENTRATIONS ARE GIVEN IN MICROLITERS PER PLATE

TEST		SPECIES	TISSUE	REVERTANTS PER PLATE					
				TA-98			TA-100		
				1	2	3	1	2	3
NONACTIVATION									
SOLVENT CONTROL		---	---	104			175		
SOLVENT CONTROL		---	---	105			174		
POSITIVE CONTROL**		---	---	508			1121		
POSITIVE CONTROL**		---	---	565			1217		
TEST COMPOUND									
5.00	UL	---	---	120			230		
10.00	UL	---	---	159			244		
25.00	UL	---	---	204			219		
50.00	UL	---	---	255			250		
ACTIVATION									
SOLVENT CONTROL		RAT	LIVER	97			138		
SOLVENT CONTROL		RAT	LIVER	101			146		
POSITIVE CONTROL***		RAT	LIVER	2245			992		
POSITIVE CONTROL***		RAT	LIVER	2296			1051		
TEST COMPOUND									
5.00	UL	RAT	LIVER	113			229		
10.00	UL	RAT	LIVER	174			197		
25.00	UL	RAT	LIVER	265			284		
50.00	UL	RAT	LIVER	438			343		

**
TA-98 2-NITROFLUORENE 10 UG/PLATE
TA-100 SODIUM AZIDE 10 UG/PLATE
SOLVENT 50 UL/PLATE

***
TA-98 2-ANTHRAMINE 2.5 UG/PLATE
TA-100 2-ANTHRAMINE 2.5 UG/PLATE

RESULTS

TABLE 9

A. NAME OR CODE DESIGNATION OF THE TEST COMPOUND: MOHAWK 1 XAD (A81-09-007-488)
B. SOLVENT: NONE
C. TEST INITIATION DATES: 03/19/82
D. TEST COMPLETION DATE: 03/22/82
F. S-9 LOT#: REKOR5
NOTE: CONCENTRATIONS ARE GIVEN IN MICROLITERS PER PLATE

TEST		SPECIES	TISSUE	REVERTANTS PER PLATE					
				TA-98			TA-100		
				1	2	3	1	2	3
NONACTIVATION									
SOLVENT CONTROL		---	---	27			101		
SOLVENT CONTROL		---	---	29			97		
POSITIVE CONTROL**		---	---	853			1328		
POSITIVE CONTROL**		---	---	849			1367		
TEST COMPOUND									
50.00	UL	---	---	118			180		
75.00	UL	---	---	-			125		
ACTIVATION									
SOLVENT CONTROL		RAT	LIVER	27			96		
SOLVENT CONTROL		RAT	LIVER	29			113		
POSITIVE CONTROL***		RAT	LIVER	1551			2337		
POSITIVE CONTROL***		RAT	LIVER	1601			2393		
TEST COMPOUND									
25.00	UL	RAT	LIVER	113			440		
50.00	UL	RAT	LIVER	235			-		

**
TA-98 2-NITROFLUORENE 10 UG/PLATE
TA-100 SODIUM AZIDE 10 UG/PLATE
SOLVENT 75 UL/PLATE
- INDICATES TEST WAS NOT DONE

***
TA-98 2-ANTHRAMINE 2.5 UG/PLATE
TA-100 2-ANTHRAMINE 2.5 UG/PLATE

Reproduced from best available copy.

```
 RESULTS                                              TABLE 10
---------------------------------

A.    NAME OR CODE DESIGNATION OF THE TEST COMPOUND:  MOHAWK2 XAD (A81-09-007-495)
B.    SOLVENT:  NONE
C.    TEST INITIATION DATES:  03/05/82
D.    TEST COMPLETION DATE: 03/08/82
E.    S-9 LOT#: RFK085
NOTE:   CONCENTRATIONS ARE GIVEN IN MICROLITERS   PER  PLATE

                                      R E V E R T A N T S   P E R   P L A T E
                                    -------------------------------------------------------------------------
TEST              SPECIES TISSUE   TA-98
----              ------- ------ ---------------
                                      1    2    3
NONACTIVATION
-------------

NEGATIVE CONTROL     ---     ---     67
NEGATIVE CONTROL     ---     ---     69
POSITIVE CONTROL**   ---     ---    948
POSITIVE CONTROL**   ---     ---    971
TEST COMPOUND
    10.00     UL     ---     ---     30

ACTIVATION
----------

NEGATIVE CONTROL     RAT    LIVER    72
NEGATIVE CONTROL     RAT    LIVER    61
POSITIVE CONTROL***  RAT    LIVER  1921
POSITIVE CONTROL***  RAT    LIVER   856
TEST COMPOUND
    10.00     UL     RAT    LIVER   134
------------------------------------------------------------------------------------------------------------

**                                                         ***
   TA-98    2-NITROFLUORENE                   10 UG/PLATE         TA-98    2-ANTHRAMINE  2.5 UG/PLATE
```

TABLE 11

RESULTS

A. NAME OP CODE DESIGNATION OF THE TEST COMPOUND: MOHAWK 2 XAD (A81-09-007-495)
B. SOLVENT: NONE
C. TEST INITIATION DATES: 03/15/82
D. TEST COMPLETION DATE: 03/18 /82
F. S-9 LOT#: REK095
NOTE: CONCENTRATIONS ARE GIVEN IN MICROLITERS PER PLATE

TEST		SPECIES	TISSUE	REVERTANTS PER PLATE					
				TA-98			TA-100		
				1	2	3	1	2	3
NONACTIVATION									
SOLVENT CONTROL		---	---	104			175		
SOLVENT CONTROL		---	---	105			174		
POSITIVE CONTROL**		---	---	508			1121		
POSITIVE CONTROL**		---	---	565			1217		
TEST COMPOUND									
5.00	UL	---	---	60			89		
10.00	UL	---	---	96			121		
25.00	UL	---	---	98			168		
50.00	UL	---	---	98			161		
ACTIVATION									
SOLVENT CONTROL		RAT	LIVER	97			138		
SOLVENT CONTROL		RAT	LIVER	101			146		
POSITIVE CONTROL***		RAT	LIVER	2245			992		
POSITIVE CONTROL***		RAT	LIVER	2286			1051		
TEST COMPOUND									
5.00	UL	RAT	LIVER	107			172		
10.00	UL	RAT	LIVER	109			184		
25.00	UL	RAT	LIVER	106			140		
50.00	UL	RAT	LIVER	105			139		

** TA-98 2-NITROFLUORENE 10 UG/PLATE
TA-100 SODIUM AZIDE 10 UG/PLATE
SOLVENT 50 UL/PLATE

*** TA-98 2-ANTHRAMINE 2.5 UG/PLATE
TA-100 2-ANTHRAMINE 2.5 UG/PLATE

TABLE 12

RESULTS

A. NAME OR CODE DESIGNATION OF THE TEST COMPOUND: MOHAWK2 XAD (AB1-09-007-495)
B. SOLVENT: NONE
C. TEST INITIATION DATES: 03/19/82
D. TEST COMPLETION DATE: 03/22/82
F. S-9 LOT#: REK085
NOTE: CONCENTRATIONS ARE GIVEN IN MICROLITERS PER PLATE

TEST	SPECIES	TISSUE	REVERTANTS PER PLATE TA-98 1	 2	 3
NONACTIVATION					
SOLVENT CONTROL	---	---	27		
SOLVENT CONTROL	---	---	20		
POSITIVE CONTROL**	---	---	853		
POSITIVE CONTROL**	---	---	849		
TEST COMPOUND 50.00 UL	---	---	24		
ACTIVATION					
SOLVENT CONTROL	RAT	LIVER	27		
SOLVENT CONTROL	RAT	LIVER	29		
POSITIVE CONTROL***	RAT	LIVER	1551		
POSITIVE CONTROL***	RAT	LIVER	1661		
TEST COMPOUND 50.00 UL	RAT	LIVER	47		

** TA-98 2-NITROFLUORENE 10 UG/PLATE
SOLVENT 75 UL/PLATE

*** TA-98 2-ANTHRAMINE 2.5 UG/PLATE

VII. ASSAY ACCEPTANCE AND EVALUATION CRITERIA

Statistical methods are not currently used, and evaluation is based on the criteria included in this protocol.

Plate test data consists of direct revertant colony counts obtained from a set of selective agar plates seeded with populations of mutant cells suspended in a semisolid overlay. Because the test material and the cells are incubated in the overlay for approximately 2 days and a few cell divisions occur during the incubation period, the test is semiquantitative in nature. Although these features of the assay reduce the quantitation of results, they provide certain advantages not contained in a quantitative suspension test:

- The small number of cell divisions permits potential mutagens to act on replication DNA, which is often more sensitive than nonreplicating DNA.
- The combined incubation of the test article and the cells in the overlay permits constant exposure of the indicator cells for approximately 2 days.

A. Surviving Populations

Plate test procedures do not permit exact quantitation of the number of cells surviving chemical treatment. At low concentrations of the test material, the surviving population on the treatment plates is essentially the same as that on the negative control plate. At high concentrations, the surviving population is usually reduced by some fraction. Our protocol will normally employ several doses ranging over two or three log concentrations, the highest of these doses being selected to show slight toxicity as determined by subjective criteria.

B. Dose-Response Phenomena

The demonstration of dose-related increased in mutant counts is an important criterion in establishing metagenicity. A factor that might modify dose-response results for a mutagen would be the selection of doses that are too low (usually mutagenicity and toxicity are related). If the highest dose is far lower than a toxic concentration, no increases may be observed over the dose range selected. Conversely, if the lowest dose employed is highly cytotoxic, the test material may kill any mutants that are induced, and the test material will not appear to be mutagenic.

C. Control Tests

Positive and negative control assays were conducted with each experiment and consisted of direct-acting mutagens for nonactivation assays and mutagens that require metabolic biotransformation in activation assays. Negative controls consisted of the test material solvent in the overlay agar together with the other essential components. The negative control plate for each strain gave a reference point to which the test data was compared. The positive control assay was conducted to demonstrate that the test systems were functional with known mutagens.

The following normal range of revertants for solvent controls are generally considered acceptable.

TA-1535:	8-30
TA-1537:	4-30
TA-98:	20-75
TA-100:	80-250

D. Evaluation Criteria for Ames Assay

Because the procedures to be used to evaluate the mutagenicity of the test material are semiquantitative, the criteria to be used to determine positive effects are inherently subjective and are based primarily on a historical data base. Most data sets will be evaluated using the following criteria.

1. Strains TA-1535 and TA-1537

If the solvent control value is within the normal range, a test material that produces a positive dose response over three concentrations with the highest increase equal to three times the solvent control value will be considered to be mutagenic.

2. Strains TA-98 and TA-100

If the solvent control value is within the normal range, a test material that produces a positive dose response over three concentrations with the highest increase equal to twice the solvent control value for TA-98 and TA-100 will be considered to be mutagenic.

3. Pattern

Because TA-1535 and TA-100 are both derived from the same parental strain (G-46), to some extent there is a built-in redundancy in the microbial assay. In general, the two strains of a set respond to the same mutagen and such a pattern is sought. Generally, if a strain responds to a mutagen in nonactivation tests, it will do so in activation tests.

4. Reproducibility

If a test material produces a response in a single test that cannot be reproduced in additional runs, the initial positive test data lose significance.

The preceding criteria are not absolute, and other extenuating factors may enter into a final evaluation decision. However, these criteria will be applied to the majority of situations and are presented to aid those individuals not familar with this procedure. As the data base is increased, the criteria for evaluation can be more firmly established.

E. Relation Between Mutagenicity and Carcinogenicity

It must be emphasized that the Ames *Salmonella*/Microsome Plate Assay is not a definitive test for chemical carcinogens. It is recognized, however, that correlative and functional relations have been demonstrated between these two endpoints. The results of comparative tests on 300 chemicals by McCann *et al*.[7] show an extremely good correlation between results of microbial mutagenesis tests and *in vivo* rodent carcinogenesis assays.

All evaluations and interpretation of the data to be presented in the final report will be based only on the demonstration, or lack, of mutagenic activity.

F. Criteria for Ranking Samples in the Ames Assay

The goal of EPA Level 1 Ames testing is to rank source streams by relative degree of genetic toxicity (mutagenicity). Samples are first identified as mutagenic or nonmutagenic by the criteria in Section D above and then ranked using the mutagenicity categories presented in the table below. The lowest concentration giving a positive response in any strain, with or without metabolic activation, is identified as the minimum effective concentration (MEC) for that sample. The mutagenicity of the sample is evaluated as high (H), moderate (M), low (L), or nondetectable (ND) according to the evaluation criteria developed in the Level 1 manual[1] and summarized below. Samples with no detectable activity at the maximum applicable dose (MAD) are ranked nondetectable (ND).

Another evaluation scheme is proposed for extracts obtained from SASS train gas volumes. The proportion of the total gas volume corresponding to the volume of extract used in the bioassay is calculated and expressed as liters per plate. A criterion of 5000 L/plate is set as the limit for nondetectable toxicity. The subsequent toxicity ranges are defined by 10-fold dilution steps to conform to standard procedure. Evaluation criteria based on equivalent gas volumes are tentative and under evaluation.

Ames Assay Mutagenicity Ranking Criteria[1]

Mutagenic Activity	Solids (MEC in μg/plate)	Liquids[a] (MEC in μl/plate)	Equivalent Gas Volumes (MEC in liters/plate)
High (H)	<50	<2	<50
Moderate (M)	50-500	2-20	50-500
Low (L)	500-5000	20-200	500-5000
Not Detectable (ND)	>5000	>200	>5000

[a] Concentration of organic extracts is based upon organic content (μg organics per plate) and not volume (μl extract per plate) of sample tested.

VIII. REFERENCES

1. Brusick, D.J. and Young, R.R.: IERL-RTP Procedures Manual: Level 1 Environmental Assessment Biological Tests. EPA-600/8-81-024, Litton Bionetics, Inc., Kensington, MD, October, 1981, 150 pp.

2. Brusick, D.J.: Level 1 Bioassay Assessment and Data Formatting. EPA-600/7-80-079, Litton Bionetics Inc., Kensington, MD, April 1980, 100 pp.

3. Brusick, D.J. and Young, R.R.: Level 1 Bioassay Sensitivity. EPA-600/7-81-135, Litton Bionetics, Inc., Kensington, MD, August 1981, 52 pp.

4. DHEW Food and Drug Administration "Nonclinical Laboratory Studies; Good Laboratory Practice Regulations." Federal Register, volume 43, No. 247, pp. 59986-60020, Part II, December 22, 1978.

5. Proposed Health Effects Test Standard for Toxic Substances Control Act Test Rules; Good Laboratory Practice Standards for Health Effects. Federal Register, Part II, volume 44, No. 91, May 1979 and Part IV, volume 44, No. 145, July, 1979.

6. Guidelines for Registering Pesticides in the United States: Proposed Good Laboratory Practice Guidelines for Toxicology Testing. Federal Register, volume 45, No. 77, April, 1980.

7. McCann, J., Choi, E., Yamasaki, E. and Ames, B.N.: Detection of carcinogens as mutagens in the Salmonella/microsome test: Assay of 300 chemicals. Proc. Nat. Acad. Sci., USA 72:5135-5139, 1975.

8. Ames, B.N., Gurney, E.G., Miller, J.A. and Bartsch, H.: Carcinogens as frameshift mutagens: Metabolites and derivatives of 2-acetylaminofluorene and other aromatic amine carcinogens. Proc. Nat. Acad. Sci., USA 69:3128-3132, 1972.

9. Ames, B.N., Lee, F.D., and Durston, W.E.: An improved bacterial test system for the detection and classification of mutagens and carcinogens. Proc. Nat. Acad. Sci., USA 70:782-786, 1973.

10. Ames, B.N., Durston, W.E., Yamasaki, E. and Lee, F.D.: Carcinogens are mutagens: A simple test system combining liver homogenates for activation and bacteria for detection. Proc. Nat. Acad. Sci., USA 70:2281-2285, 1973.

11. McCann, J., Springarn, N.E., Kobori, J. and Ames, B.N.: Detection of carcinogens as mutagens: Bacterial tester strains with R factor plasmids. Proc. Nat. Acad. Sci. USA 72:979-983, 1975.

12. Ames, B.N., McCann, J. and Yamasaki, E.: Methods for detecting carcinogens and mutagens with the *Salmonella*/mammalian-microsome mutagenicity test. Mutation Res., 31:347-364, 1975.

13. Vogel, H.J. and Bonner, D.M.: Acetylornithinase of *E. coli* partial purification and some properties. J. Biol. Chem., 218:97-106, 1966.

GENETICS ASSAY NOS. 6153-6156
LBI SAFETY NOS. 7535-7538

CYTOTOXIC EVALUATION OF XAD RESIN EXTRACTS IN THE EPA LEVEL 1 RODENT CELL (CHO) CLONAL TOXICITY ASSAY

FINAL REPORT

SUBMITTED TO:

ACUREX CORPORATION
485 CLYDE AVENUE
MOUNTAIN VIEW, CALIFORNIA 94042

SUBMITTED BY:

LITTON BIONETICS, INC.
5516 NICHOLSON LANE
KENSINGTON, MARYLAND 20895

LBI PROJECT NO. 22064

REPORT DATE: MARCH 1982

PREFACE

These assays conform to the standard EPA Level 1 procedure for the Chinese hamster ovary cell (CHO) clonal toxicity assay as described in "IERL-RTP Procedures Manual: Level 1 Environmental Assessment Biological Tests"[1]. The data were evaluated and formatted as recommended in "Level 1 Biological Testing Assessment and Data Formatting"[2].

The CHO clonal toxicity assay has been shown to be a sensitive method for detecting cytotoxic activity for a variety of chemicals representing various chemical classes [3]. This assay is one of several recommended by EPA to identify, categorize and rank the pollutant potential of influent and effluent streams from industrial and energy-producing processes. This assay has been well validated with a wide range of positive and negative control chemicals and complex environmental samples.

All procedures and documents pertaining to the receipt, storage, preparation, testing and evaluation of the test material shall conform to Litton Bionetics, Inc. standard operating procedures, the U.S. Food and Drug Administration's Good Laboratory Practices Regulations of 1979[4] and the proposed U.S. Environmental Protection Agency's Good Laboratory Practice Guidelines.[5,6] Deviations from standard procedure shall be fully documented and noted in the report.

All test and control results in this report are supported by fully documented raw data which are permanently maintained in the files of the Department of Molecular Toxicology or in the archives of Litton Bionetics, Inc., 5516 Nicholson Lane, Kensington, Maryland 20895. Copies of raw data will be supplied to the sponsor upon request.

TABLE OF CONTENTS

Page No.

PREFACE i

I. ASSAY SUMMARY 1

II. OBJECTIVE 2

III. TEST MATERIAL 3

- A. Description 3
- B. Handling and Preparation 3

IV. MATERIALS 5

- A. Indicator Cells 5
- B. Media 5
- C. Controls 6

V. EXPERIMENTAL DESIGN 7

- A. Dose Selection 7
- B. Clonal Toxicity Assay 7

VI. RESULTS 9

- A. Interpretation 9
  - 1. TOSCO 2 XAD + OMC 9
  - 2. TOSCO 1 XAD 9
  - 3. MOHAWK 1 XAD 10
  - 4. MOHAWK 2 XAD 11
- B. Tables and Figures 12

VII. ASSAY ACCEPTANCE CRITERIA 21

VIII. ASSAY EVALUATION CRITERIA 22

IX. REFERENCES 24

I. SUMMARY

Four resin extract sample supplied by Acurex Corporation were tested and evaluated for their cytotoxicities in the EPA Level 1 Chinese hamster ovary (CHO) cell clonal toxicity assay. The samples, supplied in methylene chloride, were solvent exchanged to dimethylsulfoxide (DMSO) prior to testing. The samples were identified as TOSCO 2 XAD + OMC (A81-07-011-562, 559), TOSCO 1 XAD (A81-07-011-569), MOHAWK 1 XAD (A81-09-007-488) and MOHAWK 2 XAD (A81-09-007-495).

TOSCO 2 XAD + OMC and TOSCO 1 XAD were both ranked as having moderate toxicity with EC_{50} values of 70.8 µg organics/ml and 37.4 µg organics/ml, respectively. CHO toxicity testing was limited by the small amount of test material supplied for MOHAWK 1 XAD (6 mg organics) and MOHAWK 2 XAD (4 mg organics). EC_{50} values could not be located for these two samples. No toxicity was observed up to the maximum applicable dose (MAD) of 20 µl/ml (60 µg organics/ml) with MOHAWK 1 XAD and only slight toxicity at the MAD of 20 µl/ml (40 µg organics/ml) with MOHAWK 2 XAD. Therefore, the toxicities of these two samples were evaluated as being undetermined but moderate or less.

The results indicate that quantities less than 10 mg organics of this type of sample were not sufficient for adequate Level 1 testing. While minimum testable sample size is often a function of the biological activity of the sample, efforts should be made to supply at least 20 mg of SASS train organics for combined Ames and CHO testing.

Submitted by:

Study Director

Robert Young 3-25-82
Robert Young, M.S. Date
Study Director,
Environmental Assessment
Section
Department of Molecular
Toxicology

Reviewed by:

4/7/82
David J. Brusick, Ph.D. Date
Director,
Department of Molecular
Toxicology

II. OBJECTIVE

The objective of this study was to determine and rank the cytotoxicities of four resin extract samples to cultured Chinese hamster cells (CHO-K1 cell line). The samples were solvent exchanged into dimethylsulfoxide (DMSO) before CHO testing was initiated. The measure of cytotoxicity was the reduction in colony-forming ability of CHO-K1 cells after a 24-hour exposure to the test material. After a period of recovery and growth, the number of colonies that developed in the treated cultures was compared to the colony number in unexposed vehicle control cultures. The concentration of test material that reduced the colony number by 50 percent was estimated graphically and referred to as the EC_{50} value. Standard EPA Level 1 toxicity evaluation criteria for the CHO clonal toxicity assay were used to rank the toxicity potential of each test material.

III. TEST MATERIAL

A. Description

Four samples were supplied by Acurex Corporation, Mountain View, California. The samples were assigned LBI safety numbers and LBI assay numbers upon receipt. The Acurex code numbers, sample identification, LBI safety numbers and LBI assay numbers are identified below. All laboratory documentation used the LBI assay number to identify samples.

The four test materials were received as clear, yellow solutions of organic material in methylene chloride except for the TOSCO 1 XAD sample. That sample was an amber-colored, clear solution with a few suspended particles. The quantity of organic material in each sample, as determined by Acurex Corporation, is identified below. No information on sampling parameters (such as the equivalent volume of stack gas represented by the sample) was provided.

Acurex Corp. Code	Sample Identification	Quantity (mg organic)	LBI Safety No.	LBI Assay No.
A81-07-011-562, 559	TOSCO 2 XAD + OMC	12	7537	6153
A81-07-011-569	TOSCO 1 XAD	17	7538	6154
A81-09-007-488	MOHAWK 1 XAD	6	7535	6155
A81-09-007-495	MOHAWK 2 XAD	4	7536	6156

B. Handling and Preparation

The test materials were received at LBI on February 8, 1982. The samples were shipped in small, clear-glass vials sealed with crimp-top aluminum caps with rubber liners. The samples were received intact and were stored at +4°C in the dark until processed.

Pretest sample preparation consisted of solvent exchanging the samples into dimethysulfoxide (DMSO). The samples were transferred with methylene chloride rinses into graduated conical tubes. The methyl chloride was gradually evaporated (50°C under a stream of nitrogen) and DMSO was sequentially added. The samples were brought to volume in 2.0 ml of DMSO. The samples were transferred to glass vials and sealed with teflon-coated rubber rounds. The solvent exchanged samples were stored at +4°C in the dark.

A total volume of 0.42 ml of each test sample was used in the CHO assays. The maximum concentration of 20 μl/ml was obtained by adding 0.12 ml of sample to 5.88 ml of F12 medium; this resulted in 2 percent (v/v) DMSO in the medium and effectively limited the concentration of test material that could be assayed. Only two plates were dosed at the top dose in order to conserve sample. Another 0.12 ml aliquot of sample was added to 11.88 ml of F12 medium to prepare the 10 μl/ml test concentration. An additional 0.18 ml of test sample was used to prepare a series of dilutions in DMSO from which 1:100 dilutions into growth medium were performed to obtain the lower assayed concentrations. Thus, except for the 20 μl/ml test concentrations, the final DMSO concentration was constant at 1 percent (v/v).

IV. MATERIALS

A. Indicator Cells

The indicator cells for these assays were Chinese hamster CHO-K1 cells (ATCC No. CCL 61) obtained from Flow Laboratories, Inc., Rockville, MD. This cell type was derived from ovarian tissue and has spontaneously transformed to a stable, hypodiploid line of rounded, fibroblastic cells with unlimited growth potential. Monolayer cultures have a fast doubling time of 11 to 14 hours, and untreated cells can normally be cloned with an efficiency of 80 percent or greater. Laboratory stocks were maintained by routine serial subpassage. Cells were cultivated in Ham's F-12 nutrient medium at 37°C in an atmosphere of 5 percent CO_2 and saturated humidity. Stocks were continually observed macroscopically and microscopically for possible microbial contamination. Laboratory cultures were periodically checked by culturing and staining methods for the absence of mycoplasma contamination. Laboratory cultures were discarded every three months and new cultures started from mycoplasma-free, long-term frozen cultures.

B. Media

The CHO-K1 cell line has an absolute requirement for proline and therefore must be maintained in culture medium containing sufficient amounts of this amino acid. Ham's F12 medium, which contains 3×10^{-4} M L-proline was used, supplemented with 10 percent fetal bovine serum, 2mM L-glutamine, 100 units/ml of penicillin, 100 µg/ml of streptomycin, and 0.9 µl/ml of amphotericin B.

C. Controls

The negative control for all four assays consisted of three untreated cultures in F12 medium carried through the same experimental time period as the treated cells. Since the test materials were tested as solutions in an organic vehicle (DMSO) and were diluted into the medium to provide each test concentration, two sets of vehicle control cultures containing

DMSO at one percent and two percent by volume were prepared in triplicate for each assay. The average number of colonies in the negative control established the cloning efficiency of the CHO cells used in the assays and the appropriate vehicle controls provided the reference points for determining the effects of different concentrations of the solid test materials on cell survival.

V. EXPERIMENTAL DESIGN

A. Dose Selection

Unless the approximate toxicity is already known, or the sample size is limiting, the following minimum dose ranges are recommended by the Level 1 manual[1] for testing different sample forms. Aqueous samples, suspensions, or slurries are tested from 600 µl/ml to 6 µl/ml, usually in five dose steps. Dry, particluate material is dissolved or suspended in culture medium and tested at five dose levels from 1000 µg/ml to 10 µg/ml. Samples that are solvent-exchanged into DMSO are tested from 20 µl/ml to 0.5 µl/ml, in five dose steps. Eight doses are often used when the amount of test sample is limited to provide a more precise description of toxicity in the event of sharp dose-response curves. A second dose study is performed with an adjusted dose range if the EC_{50} was not located properly in the initial test. However, EC_{50} values greater than 1000 µg/ml for particulate material, 600 µl/ml for aqueous samples, or 20 µl/ml for organic solutions will not be determined.

In this work the test materials were tested as resin extracts in an organic vehicle. The concentrations used for the samples started with the maximum applicable dose (MAD) of 20 µl/ml and included seven other doses that were 10, 6, 3, 1, 0.6, 0.3 and 0.1 µl/ml.

B. Clonal Toxicity Assay

Cells from monolayer stock cultures in logarithmic growth phase were trypsinized with 0.1 percent trypsin plus 0.01 percent versene for 4 minutes, and the density of the resulting cell suspension was determined by hemocytometer. A number of 60-mm culture dishes were then seeded with 200 cells and 4 ml of culture medium per dish. The cultures were incubated for approximately 6 hours at 37°C in a humidified atmosphere containing 5 percent CO_2 to allow attachment of the cells. The 6-hour attachment period was used in order to avoid cell division and the subsequent formation of two-cell colonies prior to treatment.

The medium was aspirated from the cultures and 4 ml of control medium or medium containing the test material was applied. Three cultures were exposed to each test concentration. After an exposure time of 24 hours at 37°C, the medium was removed by aspiration and each culture washed two times with approximately 4 ml aliquots of Dulbecco's phosphate buffered saline (pre-warmed to 37°C). Fresh culture medium (5 ml) was placed in each dish, and incubation at 37°C was continued for an additional 6 days to allow colony development.

If the test material caused a color change in the culture medium, the pH of the medium containing the high dose would be determined at the time of treatment. The pH at the lowest dose that results in a slight color change would also be recorded. At the end of the treatment period, the pH values of the discarded media from the two described treatments would be recorded again. No sample-related pH changes were noted in any of the treatments.

After the incubation period, the medium was drained from the cultures, and the surviving colonies were fixed with 100 percent ethanol and stained with Giemsa. Colonies were counted by eye; tiny colonies of approximately 50 cells or less were arbitrarily excluded from the counts.

VI. RESULTS

A. Interpretation

The results of the Chinese hamster ovary (CHO) clonal toxicity assays are presented in Tables 1 through 4. The calculated relative survival values were obtained by comparing the average number of colonies per dish for each of the assayed concentrations to the appropriate control value. The relative survival values were then plotted as functions of the applied concentration of test material per ml of culture medium in Figures 1 through 4. Curves were fitted to the data points by eye in order to determine the EC_{50} value for each sample and to rank each sample according to EPA Level 1 evaluation criteria presented in Section VIII.

1. TOSCO 2 XAD + OMC (A81-07-011-562, 559)

The application of the DMSO solution of the TOSCO 2 XAD + OMC sample (A81-07-011-562, 559) to the CHO cell cultures caused a rapid lowering of the number of cells able to form colonies as the concentration was increased above 6.0 μl/ml. As shown in Figure 1, the relative survival remained above 90 percent in the 0.1 to 6.0 μl/ml range but dropped to zero at the 20.0 μl/ml dose level. The full range of survival was expressed between 6 μl/ml (>90 percent relative survival) and 20 μl/ml (0 percent relative survival).

The concentration expected to kill 50 percent of the cells (EC_{50}) was found to be 11.8 μl of test material per ml of culture medium. The concentration was equivalent to 70.8 μg of organic material per ml of culture medium. This value placed the test material in the moderate (M) toxicity range defined for the IERL-EPA CHO clonal toxicity bioassay[1].

2. TOSCO 1 XAD (A81-07-011-569)

The TOSCO 1 XAD sample (A81-07-011-569) in DMSO was found to be toxic to CHO cells in culture at concentrations above 1.0 μl/ml. The ability of CHO cells to form colonies was unaffected by a 24-hour exposure to concentrations of test material between 0.1 and 1.0 µl/ml. The relative survival values covered the full range of toxicity between 1 µl/ml (104.3 percent relative survival) and 10 µl/ml (0 percent relative survival).

The EC_{50} was found to be 4.4 µl of test material per ml of culture medium. This concentration was equivalent to 37.4 µg of organic material per ml of culture medium. The test material was ranked as having moderate (M) toxicity based upon the evaluation criteria developed for the IERL-EPA CHO clonal toxicity bioassay[1].

3. MOHAWK 1 XAD (A81-09-007-488)

The exposure of CHO cells in culture to the MOHAWK 1 XAD sample (A81-09-007-488) in DMSO essentially caused no decrease in the number of cells able to form colonies as the concentration was increased to the maximum applicable dose (MAD) of 20 µl/ml. As shown in Figure 3 the relative survival to all of the treatments remained above 90 percent.

Since none of the tested doses caused killing that even approached 50 percent of the cells, an EC_{50} could not be estimated. However, the lack of toxicity at the MAD of 20 µl/ml (60 µg organics/ml) excluded the sample from the high toxicity category and from at least 60 percent of the moderate toxicity range, based on the IERL-RTP evaluation criteria[1]. Because very sharp and well-defined toxicity curves have been observed with similar samples, it is possible that if sufficient test material had been supplied, toxicity could have been observed in the moderate or low toxicity ranges. The toxicity of the sample was therefore evaluated as undetermined but moderate (M) or less.

Testing and evaluating materials such as this sample indicate the need to supply sufficient quantities of test material to ensure adequate testing. While minimum testable sample size is often a function of the biological activity of the sample, efforts should be made to supply at least 20 mg of SASS train organics for combined Ames and CHO testing.

4. MOHAWK 2 XAD (A81-09-007-495)

The application of DMSO solution of the MOHAWK 2 XAD sample (A81-09-007-495) to the CHO cells in culture caused only a small decrease in the number of cells able to form colonies as the concentration was increased to the maximum applicable dose (MAD) of 20 µl/ml. Relative survival remained above 90 percent between 0.1 and 3 µl/ml. Between 3 and 10 µl/ml there was a noticable increase in sample toxicity. As shown in Figure 4, the relative survival decreased to about 72 percent for the 20 µl/ml treatment.

Since none of the tested doses caused killing approaching 50 percent of the cells, an EC_{50} could not be calculated. However, an EC_{50} value greater than 20 µl/ml (40 µg organics/ml) excluded the sample from the high toxicity category and nearly half of the moderate toxicity categories based on the IERL-RTP evaluation criteria[1]. The plotted results suggested the possibility of an EC_{50} in the 30 to 90 µl/ml range (60 to 180 µg organics/ml), so the sample could have been evaluated as having moderate or low toxicity had sufficient sample been available. The toxicity of the sample was therefore evaluated as undetermined but moderate (M) or less.

Testing and evaluating materials such as this sample and MOHAWK 1 XAD indicate the need to supply sufficient quantities of test material to ensure adequate testing. Only 4 mg of organic material was supplied for both Ames and CHO testing - an insufficient quantity for adequate testing for all but the most mutagenic and toxic samples.

The cells used for the four assays were in logarithmic growth phase and the cells in suspension prior to cell plating were 99.6 percent viable as determined by trypan blue dye exclusion. Greater than 77 percent of the seeded cells formed colonies in the negative controls for each of the four assays (80.5 ± 2.9 percent). Colony growth was normal and well distributed on the culture dishes in all trials. The combined results achieved the assay acceptance criteria discussed in Section VII, which provided confidence in the assumption that the recorded data represented typical responses to the test materials.

B. Tables and Figures

This report is based on the data provided in Tables 1 through 4 and Figures 1 through 4.

TABLE 1

CLONAL CYTOTOXICITY ASSAY

SAMPLE IDENTITY: TOSCO 2 XAD + OMC
(A81-07-011-562, 559)

DESCRIPTION OF SAMPLE: CLEAR, YELLOW LIQUID

LBI ASSAY NO. 6153

DATE RECEIVED: FEBRUARY 8, 1982

TEST DATE: MARCH 4, 1982

VEHICLE: DIMETHYLSULFOXIDE (DMSO)

CELL TYPE: CHO-K1

CELLS SEEDED PER DISH: 200

EC50 VALUE: 70.8 UG/ML (11.8 UL/ML)

TOXICITY
CLASSIFICATION: MODERATE (M)

PH ALTERATIONS: NONE

COMMENTS ON TREATMENT: 12 MG OF ORGANIC MATERIAL WERE SUPPLIED FOR TESTING. SAMPLE WAS SOLVENT EXCHANGED INTO 2.0 ML DMSO GIVING A PRIMARY STOCK CONCENTRATION OF 6 UG ORGANIC PER UL OF DMSO.

SAMPLE	APPLIED CONCENTRATION UL/ML	COLONY COUNTS DISH #1	DISH #2	DISH #3	AVERAGE COUNT	RELATIVE SURVIVAL* (PERCENT)	CLONING EFFICIENCY (PERCENT)
NC	---	165	180	162	169.0	100.0	84.5
VC, 1%	10	144	167	157	156.0	100.0	78.0
VC, 2%	20	156	155	149	153.3	100.0	76.7
TEST	0.1	160	167	161	162.7	104.3	
TEST	0.3	169	157	149	158.3	101.5	
TEST	0.6	165	159	156	160.0	102.6	
TEST	1.0	146	159	152	152.3	97.6	
TEST	3.0	153	158	143	151.3	97.0	
TEST	6.0	149	142	152	147.7	94.7	
TEST	10.0	104	114	105	107.7	69.0	
TEST	20.0	0	0	S	0.0	0.0	

NC = NEGATIVE CONTROL, F12 MEDIUM
VC = VEHICLE CONTROL, PERCENT GIVEN FOR DIMETHYLSULFOXIDE (DMSO)

S = PLATE NOT SET UP TO CONSERVE LIMITED SAMPLE

*RELATIVE TO 2% VC FOR 20 UL/ML TREATMENT AND TO 1% VC FOR OTHER TREATMENTS

Reproduced from best available copy.

TABLE 2

CLONAL CYTOTOXICITY ASSAY

SAMPLE IDENTITY: TOSCO 1 XAD
 (AR1-07-011-569)

DESCRIPTION OF SAMPLE: CLEAR, YELLOW LIQUID

LBI ASSAY NO. 6154

DATE RECEIVED: FEBRUARY 8, 1982

TEST DATE: MARCH 4, 1982

VEHICLE: DIMETHYLSULFOXIDE (DMSO)

CELL TYPE: CHO-K1

CELLS SEEDED PER DISH: 200

EC50 VALUE: 37.4 UG/ML (4.4 UL/ML)

TOXICITY
CLASSIFICATION: MODERATE (M)

PH ALTERATIONS: NONE

COMMENTS ON TREATMENT: 17 MG OF ORGANIC MATERIAL WERE SUPPLIED FOR TESTING. SAMPLE WAS SOLVENT EXCHANGED INTO 2.0 ML DMSO GIVING A PRIMARY STOCK CONCENTRATION OF 8.5 UG ORGANIC PER UL DMSO.

SAMPLE	APPLIED CONCENTRATION UL/ML	COLONY COUNTS DISH #1	DISH #2	DISH #3	AVERAGE COUNT	RELATIVE SURVIVAL* (PERCENT)	CLONING EFFICIENCY (PERCENT)
NC	---	144	169	165	159.3	100.0	79.7
VC, 1%	10	154	142	145	147.0	100.0	73.5
VC, 2%	20	154	144	140	146.0	100.0	73.0
TEST	0.1	154	148	140	147.3	100.2	
TEST	0.3	138	153	149	146.7	99.8	
TEST	0.6	137	146	156	146.3	99.5	
TEST	1.0	148	150	149	149.0	101.4	
TEST	3.0	115	127	120	120.7	82.1	
TEST	6.0	38	38	27	34.3	23.3	
TEST	10.0	0	0	0	0.0	0.0	
TEST	20.0	0	0	S	0.0	0.0	

NC = NEGATIVE CONTROL, F12 MEDIUM
VC = VEHICLE CONTROL, PERCENT GIVEN FOR DIMETHYLSULFOXIDE (DMSO)

S = PLATE NOT SET UP TO CONSERVE LIMITED SAMPLE

*RELATIVE TO 2% VC FOR 20 UL/ML TREATMENT AND TO 1% VC FOR OTHER TREATMENTS

TABLE 3

CLONAL CYTOTOXICITY ASSAY

SAMPLE IDENTITY: MOHAWK 1 XAD
(A81-09-007-488)

DESCRIPTION OF SAMPLE: CLEAR, AMBER LIQUID
WITH SUSPENDED PARTICLES

LBI ASSAY NO. 6155

DATE RECEIVED: FEBRUARY 8 1982

TEST DATE: MARCH 4, 1982

VEHICLE: DIMETHYLSULFOXIDE (DMSO)

CELL TYPE: CHO-K1

CELLS SEEDED PER DISH: 200

EC50 VALUE: > 60 UG/ML (> 20 UL/ML)

TOXICITY
CLASSIFICATION: UNDETERMINED

PH ALTERATIONS: NONE

COMMENTS ON TREATMENT: 6 MG OF ORGANIC MATERIAL WERE SUPPLIED FOR TESTING. SAMPLE WAS SOLVENT EXCHANGED INTO 2.0 ML DMSO GIVING A PRIMARY STOCK CONCENTRATION OF 3 UG ORGANIC PER UL DMSO.

SAMPLE	APPLIED CONCENTRATION UL/ML	COLONY COUNTS DISH #1	DISH #2	DISH #3	AVERAGE COUNT	RELATIVE SURVIVAL* (PERCENT)	CLONING EFFICIENCY (PERCENT)
NC	---	160	171	150	160.3	100.0	80.2
VC, 1%	10	135	148	149	144.0	100.0	72.0
VC, 2%	20	137	151	146	144.7	100.0	72.4
TEST	0.1	142	150	157	149.7	104.0	
TEST	0.3	153	135	140	142.7	99.1	
TEST	0.6	142	150	140	144.0	100.0	
TEST	1.0	130	143	132	135.0	93.8	
TEST	3.0	129	124	129	127.3	88.4	
TEST	6.0	131	129	135	131.7	91.5	
TEST	10.0	132	129	130	130.3	90.5	
TEST	20.0	135	137	S	136.0	94.0	

NC = NEGATIVE CONTROL, F12 MEDIUM
VC = VEHICLE CONTROL, PERCENT GIVEN FOR DIMETHYLSULFOXIDE (DMSO)

S = PLATE NOT SET UP TO CONSERVE LIMITED SAMPLE

*RELATIVE TO 2% VC FOR 20 UL/ML TREATMENT AND TO 1% VC FOR OTHER TREATMENTS

TABLE 4

CLONAL CYTOTOXICITY ASSAY

SAMPLE IDENTITY: MOHAWK 2 XAD
(AB1-09-007-495)

DESCRIPTION OF SAMPLE: CLEAR, YELLOW LIQUID

LBI ASSAY NO. 6156

DATE RECEIVED: FEBRUARY 8, 1982

TEST DATE: MARCH 4, 1982

VEHICLE: DIMETHYLSULFOXIDE (DMSO)

CELL TYPE: CHO-K1

CELLS SEEDED PER DISH: 200

EC50 VALUE: 60 TO 180 UG/ML (30 TO 90UL/ML)

TOXICITY
CLASSIFICATION: UNDETERMINED

PH ALTERATIONS: NONE

COMMENTS ON TREATMENT: 4 MG OF ORGANIC MATERIAL WERE SUPPLIED FOR TESTING. SAMPLE WAS SOLVENT EXCHANGED INTO 2.0 ML DMSO GIVING A PRIMARY STOCK CONCENTRATION OF 2 UG ORGANIC PER UL DMSO.

SAMPLE	APPLIED CONCENTRATION UL/ML	COLONY COUNTS			AVERAGE COUNT	RELATIVE SURVIVAL* (PERCENT)	CLONING EFFICIENCY (PERCENT)
		DISH #1	DISH #2	DISH #3			
NC	---	164	153	149	155.3	100.0	77.7
VC, 1%	10	143	148	156	149.0	100.0	74.5
VC, 2%	20	150	147	148	148.3	100.0	74.2
TEST	0.1	148	153	156	152.3	102.2	
TEST	0.3	139	153	149	147.0	98.7	
TEST	0.6	143	139	145	142.3	95.5	
TEST	1.0	138	142	149	143.0	96.0	
TEST	3.0	133	143	144	140.0	94.0	
TEST	6.0	125	134	137	132.0	88.6	
TEST	10.0	113	128	123	121.3	81.4	
TEST	20.0	103	110	S	106.5	71.8	

NC = NEGATIVE CONTROL, F12 MEDIUM
VC = VEHICLE CONTROL, PERCENT GIVEN FOR DIMETHYLSULFOXIDE (DMSO)

S = PLATE NOT SET UP TO CONSERVE LIMITED SAMPLE

*RELATIVE TO 2% VC FOR 20 UL/ML TREATMENT AND TO 1% VC FOR OTHER TREATMENTS

FIGURE 1

RODENT CELL (CHO) CLONAL TOXICITY ASSAY

EC_{50} DETERMINATION

TOSCO 2 XAD + OMC

A81-07-011-562, 559

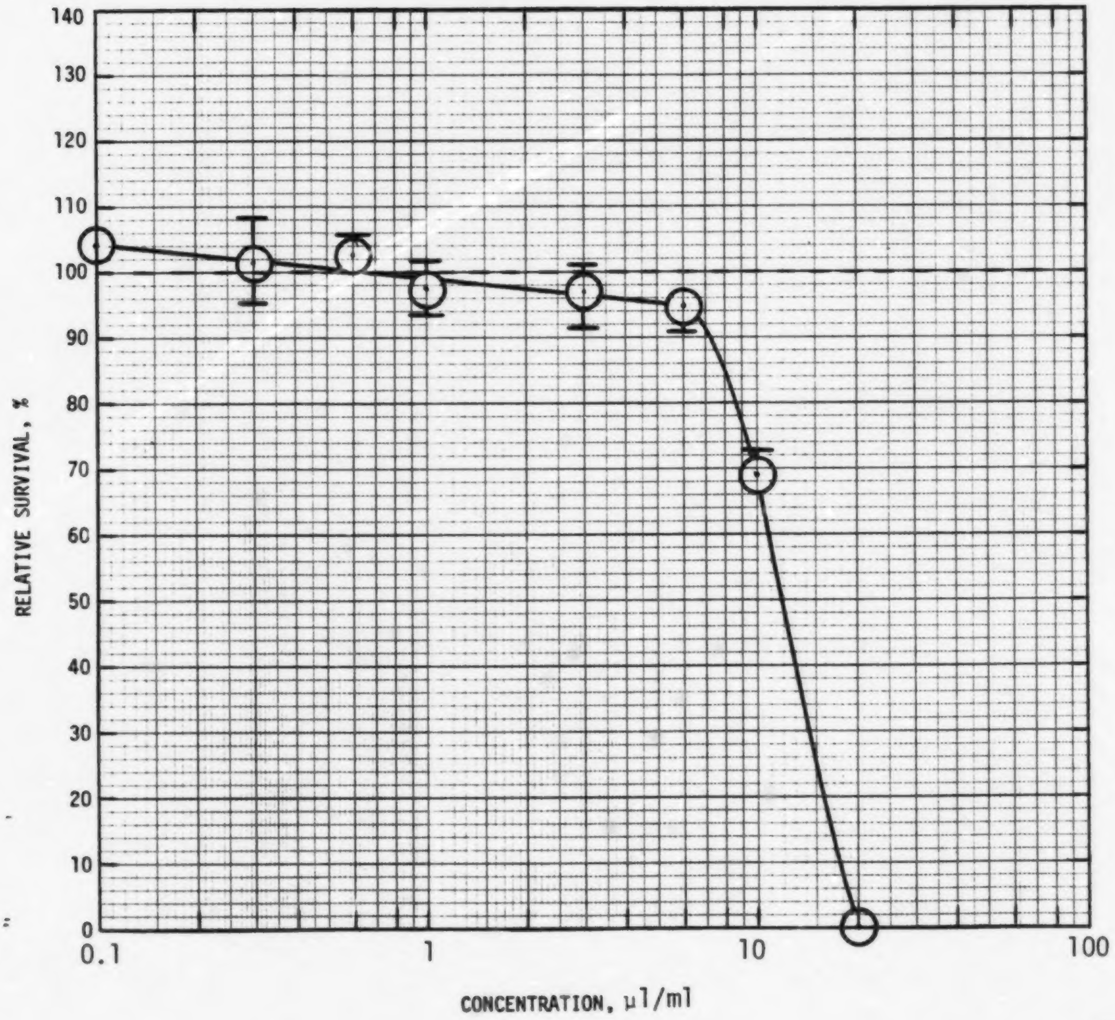


FIGURE 2

RODENT CELL (CHO) CLONAL TOXICITY ASSAY

EC_{50} DETERMINATION

TOSCO 1 XAD

A81-07-011-569

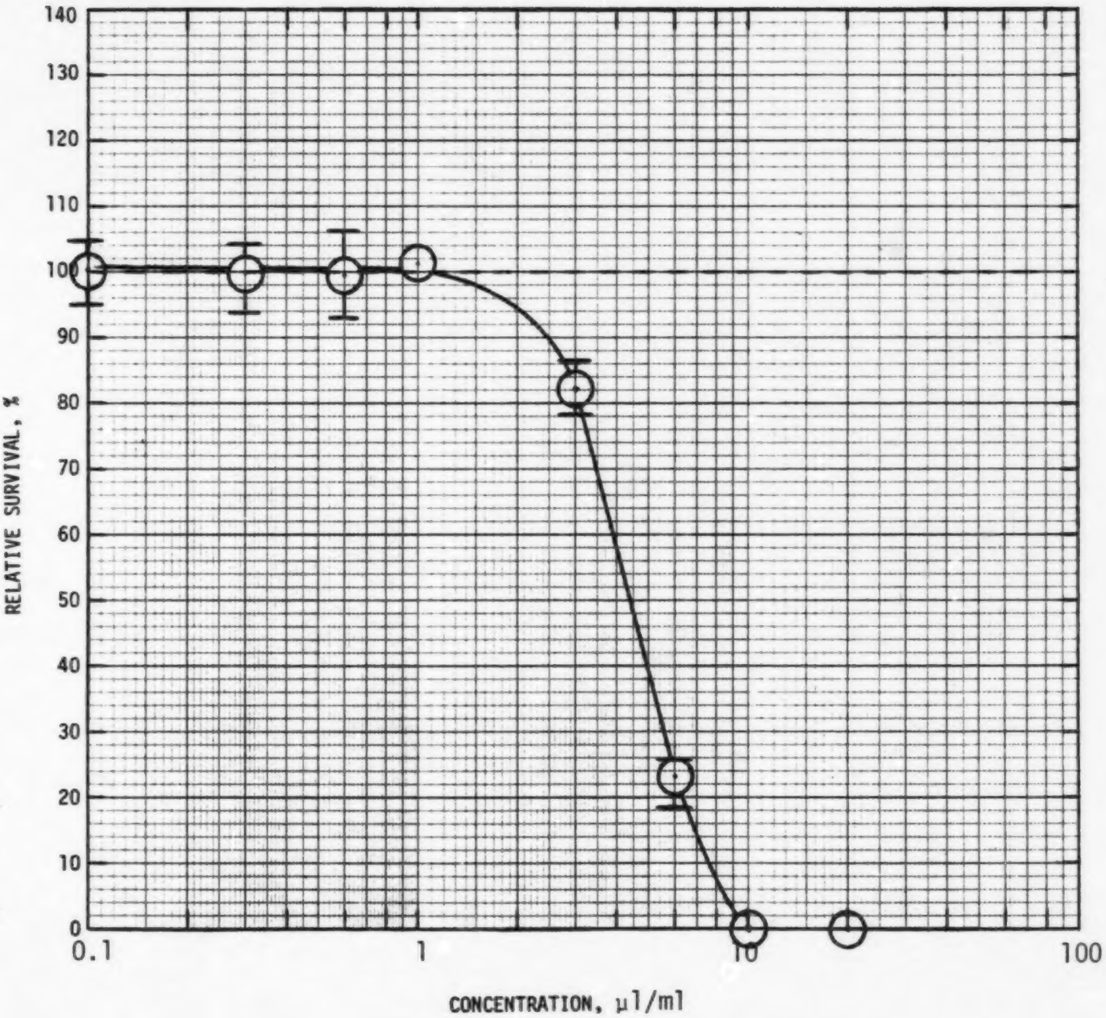


FIGURE 3

RODENT CELL (CHO) CLONAL TOXICITY ASSAY

EC_{50} DETERMINATION

MOHAWK 1 XAD

A81-09-007-488

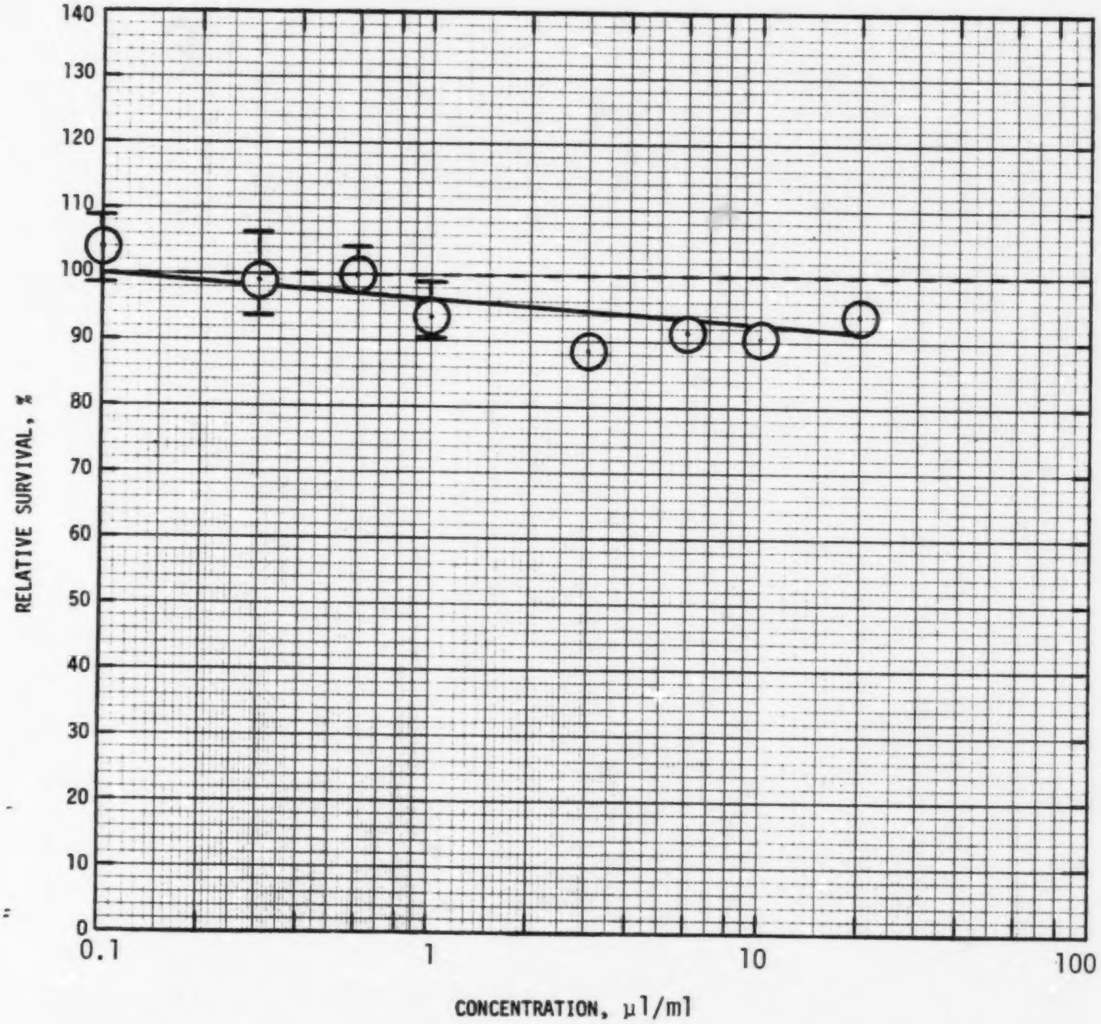


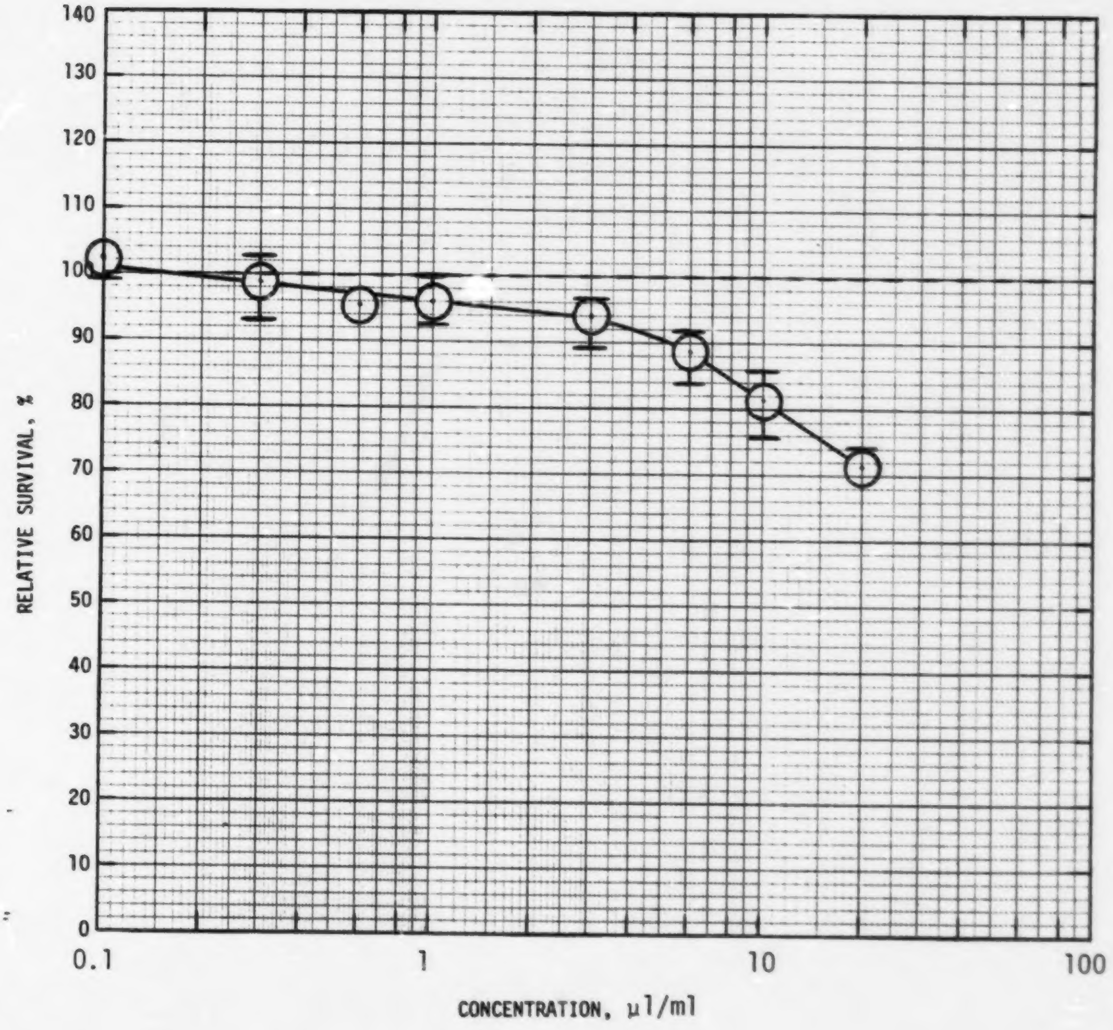
FIGURE 4

RODENT CELL (CHO) CLONAL TOXICITY ASSAY

EC_{50} DETERMINATION

MOHAWK 2 XAD

A81-09-007-495



VII. ASSAY ACCEPTANCE CRITERIA

The assay is considered acceptable for evaluation of the test results if the following criteria are met:

- The average cloning efficiency of the CHO-K1 cells in the negative controls is 70 percent or greater, but not exceeding 115 percent.
- The distribution of colonies in the treated cultures is generally uniform over the surface of the culture dish.
- The data points for each test concentration critical to the location of the EC_{50} are the averages of at least two treated cultures.
- A sufficient number of test concentrations are available to clearly locate the EC_{50} within a toxicity region as defined under Assay Evaluation Criteria.
- If the EC_{50} value is greater than 1000 μg/ml, 600 μliters of aqueous sample/ml, or 20 μliters of nonaqueous sample/ml, the plotted curve does not exceed 110 percent of the negative control.

VIII. ASSAY EVALUATION CRITERIA

The EC_{50} value represents the concentration of test material that reduces the colony-forming ability of CHO cells to 50 percent of the vehicle or negative control value. EC_{50} values are determined graphically by fitting a curve by eye through relative survival data plotted as a function of the logarithm of the applied concentration. Each data point normally represents the average of three culture dishes. In order to indicate the variability of the data, the high and low colony counts for each concentration are used to calculate the relative survivals, and the range is shown by a bar at the position of the plotted average. If no bar is shown, the variability was within the size of the symbol. Statistical analysis is unnecessary in most cases for evaluation.

The toxicity of the test material is evaluated as high, moderate, low, or nondetectable according to the range of EC_{50} values defined in the following table:

CHO ASSAY EVALUATION CRITERIA

Toxicity[a]	Solids (EC_{50} in µg/ml)	Aqueous Liquids (EC_{50} in µl/ml)	Nonaqueous Liquids[b] (EC_{50} in µl/ml)
High	<10	<6	<0.2
Moderate	10 to 100	6 to 60	0.2-2
Low	100 to 1000	60 to 600	2-20
Not Detectable	>1000	>600	>20

[a] Evaluation criteria formulated by Litton Bionetics, Inc. for IERL-RTP Procedures Manual: Level 1 Environmental Assessment Biological Tests[1].

[b] Criteria for nonaqueous liquids are tentative and under evaluation. If the organic or solids content is known, the sample is evaluated under the solids criteria.

Another evaluation scheme is proposed for extracts obtained from SASS train gas volumes. The proportion of the total gas volume corresponding to the volume of extract used in the bioassay is calculated and expressed as liters of gas per milliliter of culture medium (L/ml) or as dry standard cubic feet of gas per milliliter of culture medium (DSCF/ml). A criterion of 1000 L/ml is set as the limit for nondetectable toxicity. This gas volume corresponds to the average volume breathed by humans over a 2-hour period. The subsequent toxicity ranges are defined by 10-fold dilution steps to conform to standard procedure. The toxicity ranges are defined in the following table for liter and dry standard cubic feet units:

Toxicity	EC_{50} In Liters/ml (L/ml)	EC_{50} In Dry Standard Cubic Feet/ml (DSCF/ml)
High	<10	<0.35
Moderate	10-100	0.35-3.5
Low	100-1000	3.5-35
Nondetectable	>1000	>35

IX. REFERENCES

1. Brusick, D.J. and Young, R.R.: IERL-RTP Procedures Manual: Level 1 Environmental Assessment Biological Tests. EPA-600/8-81-024, Litton Bionetics, Inc., Kensington, MD, October 1981, 150 pp.

2. Brusick, D.J.: Level 1 Bioassay Assessment and Data Formatting. EPA-600/7-80-079, Litton Bionetics, Inc., Kensington, MD, April 1980, 100 pp.

3. Brusick, D.J. and Young, R.R.: Level 1 Bioassay Sensitivity. EPA-600/7-81-135, Litton Bionetics, Inc., Kensington, MD, August 1981, 52 pp.

4. DHEW Food and Drug Administration "Nonclinical Laboratory Studies; Good Laboratory Practice Regulations" Federal Register, volume 43, No. 247, pp. 59986-60020, Part II, December 22, 1978.

5. Proposed Health Effects Test Standard for Toxic Substances Control Act Test Rules; Good Laboratory Practice Standards for Health Effects. Federal Register, Part II, volume 44, No. 91, May 1979 and Part IV, volume 44, No. 145, July, 1979.

6. Guidelines for Registering Pesticides in the United States: Proposed Good Laboratory Practice Guidelines for Toxicology Testing. Federal Register, volume 45, No. 77, April, 1980.